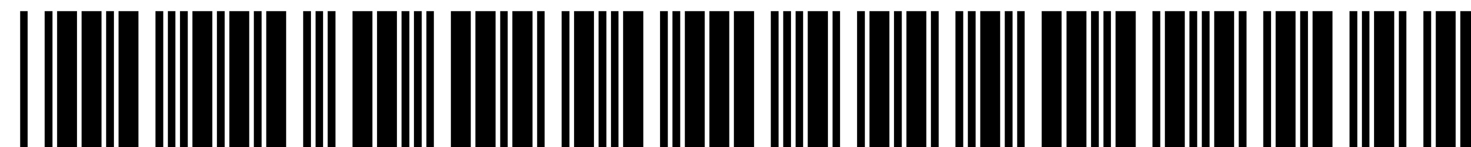
US008238109B2

(12) **United States Patent**
Sagisaka

(10) **Patent No.: US 8,238,109 B2**
(45) **Date of Patent: *Aug. 7, 2012**

(54) **FLEX-RIGID WIRING BOARD AND ELECTRONIC DEVICE**

(75) Inventor: **Katsumi Sagisaka**, Ogaki (JP)

(73) Assignee: **IBIDEN Co., Ltd.**, Ogaki-shi (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 236 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/489,999**

(22) Filed: **Jun. 23, 2009**

(65) **Prior Publication Data**

US 2010/0014265 A1 Jan. 21, 2010

Related U.S. Application Data

(60) Provisional application No. 61/081,176, filed on Jul. 16, 2008.

(51) **Int. Cl.**
H05K 1/00 (2006.01)

(52) **U.S. Cl.** **361/749**; 361/748; 361/760; 361/803; 174/254; 174/255; 174/258; 174/259; 174/260; 174/261; 174/262; 174/264; 29/830; 439/67; 439/77

(58) **Field of Classification Search** 361/749, 361/748, 760, 803; 174/254, 255, 258–264; 29/830; 439/67, 77
See application file for complete search history.

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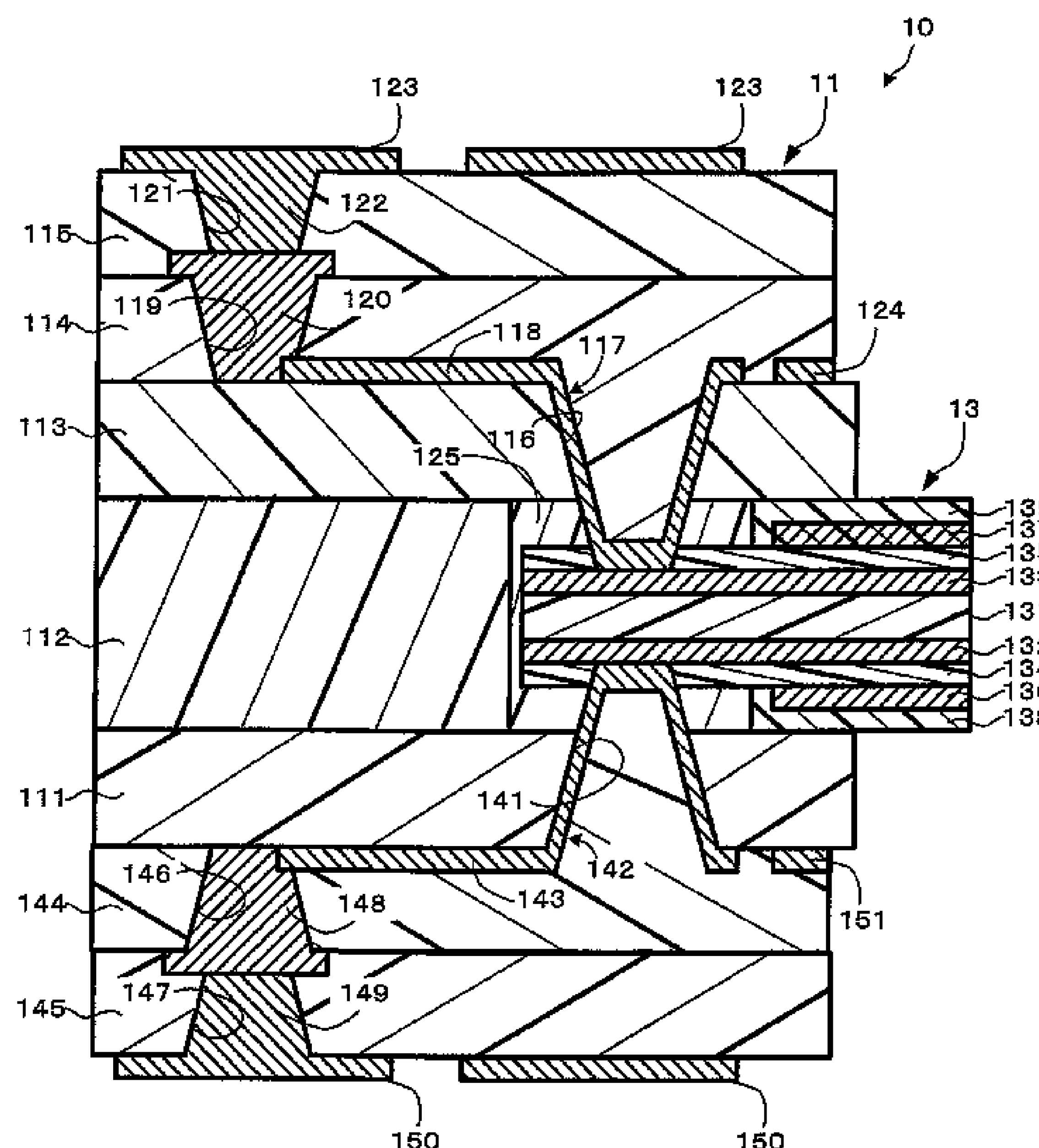
Primary Examiner — Xiaoliang Chen
(74) *Attorney, Agent, or Firm* — Oblon, Spivak, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A flex-rigid wiring board including a flexible printed wiring board, a rigid printed wiring board, a first connection terminal formed over the rigid printed wiring board and positioned to be mounted onto a motherboard, and a second connection terminal formed over the rigid printed wiring board and positioned to mount an electronic component. The flexible printed wiring board has a first conductive layer, the rigid printed wiring board has a rigid base material, an insulation layer over the rigid base material and a second conductive layer formed over the insulation layer. The insulation layer covers at least a portion of the flexible printed wiring board and at least a portion of the rigid base material while exposing at least a portion of the flexible printed wiring board, and the first conductive layer and the second conductive layer are connected through a plated metallic layer penetrating through the insulation layer.

23 Claims, 23 Drawing Sheets



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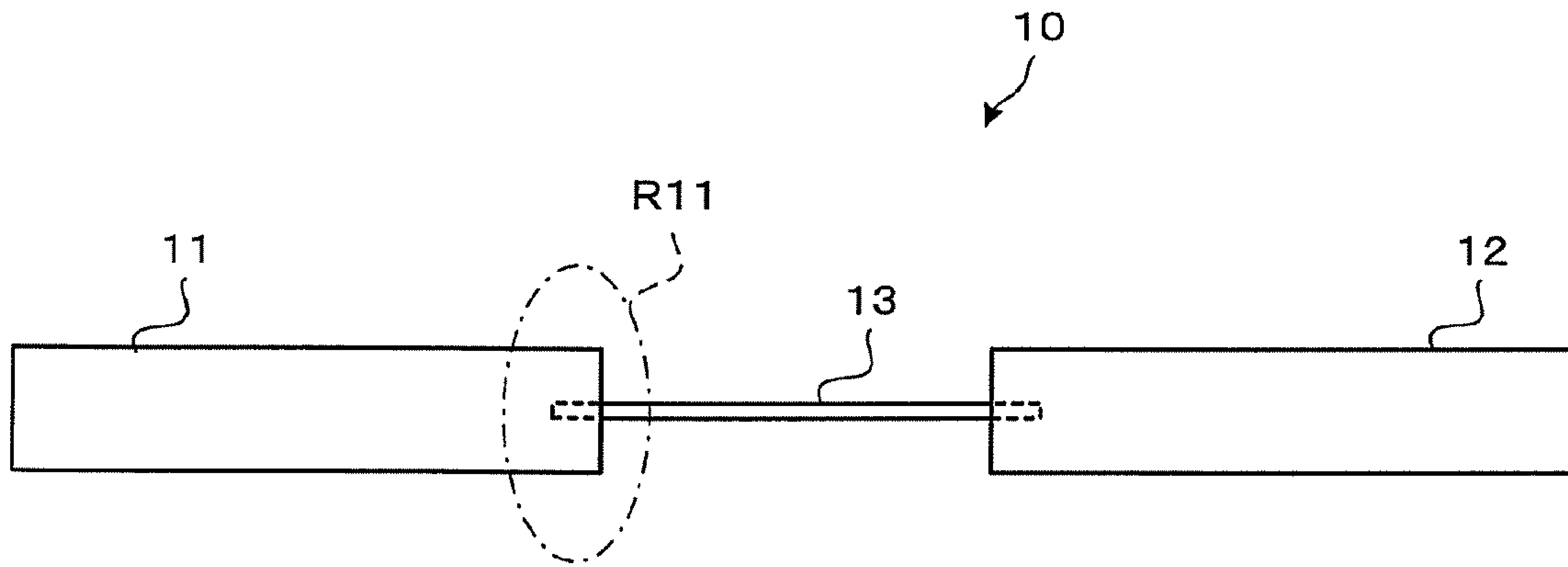

FIG. 1A

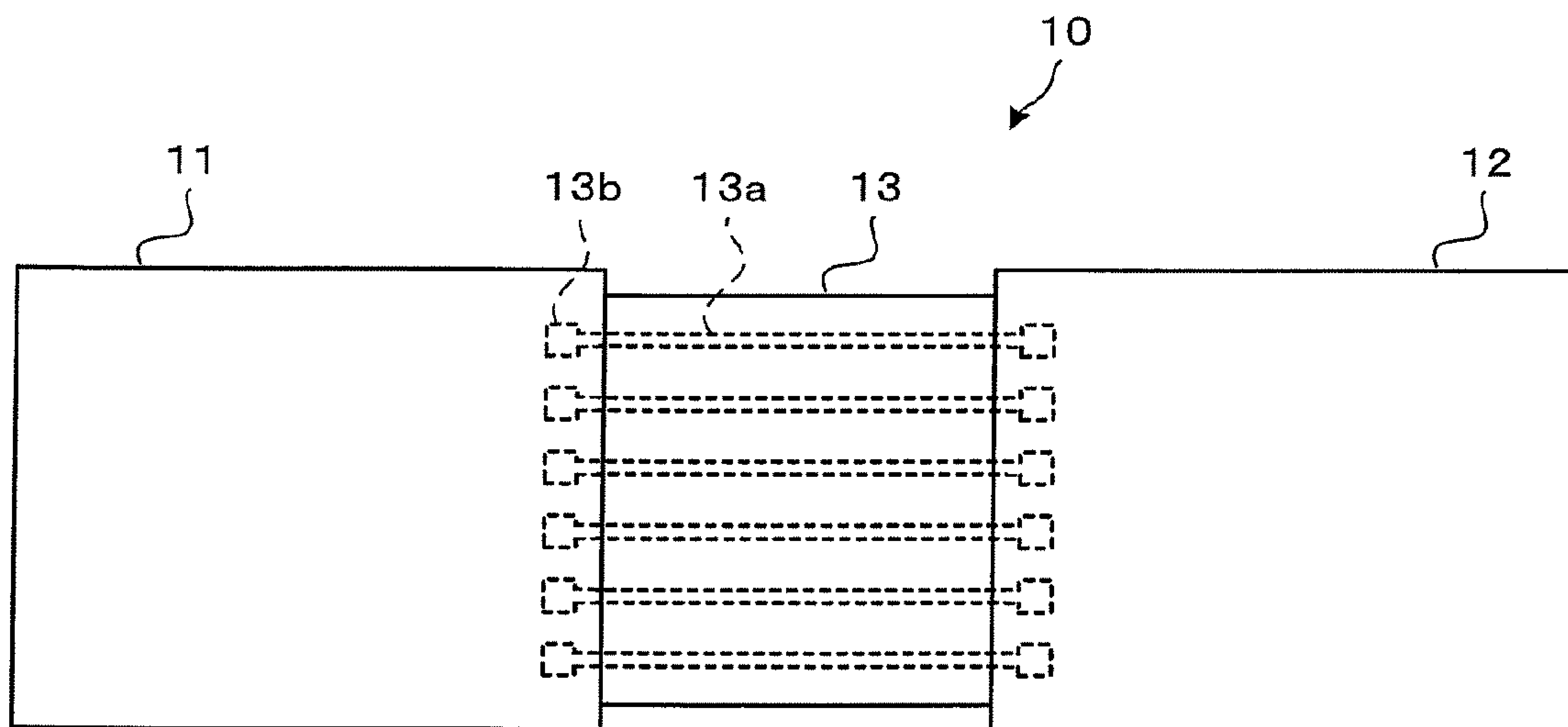

FIG. 1B

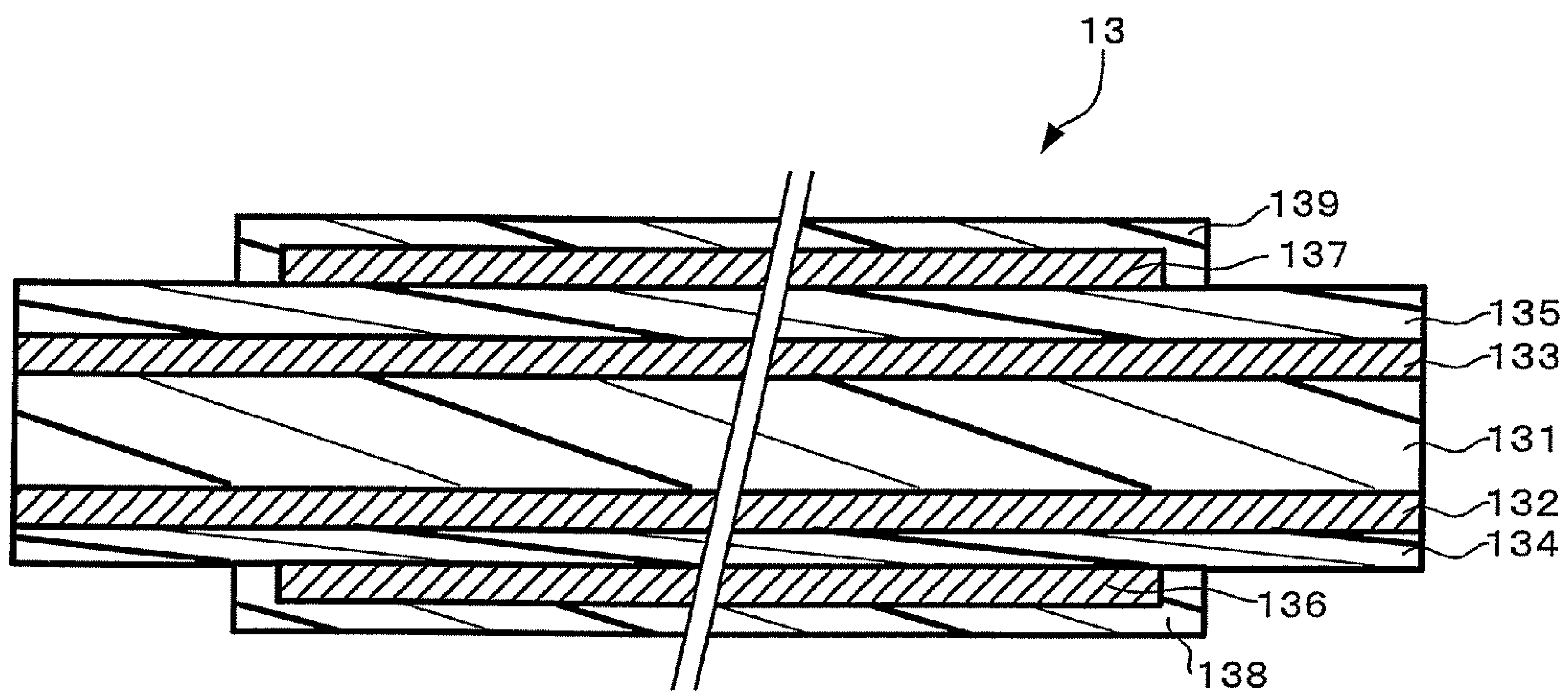

FIG. 2

FIG. 3

10
123
123
11
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118
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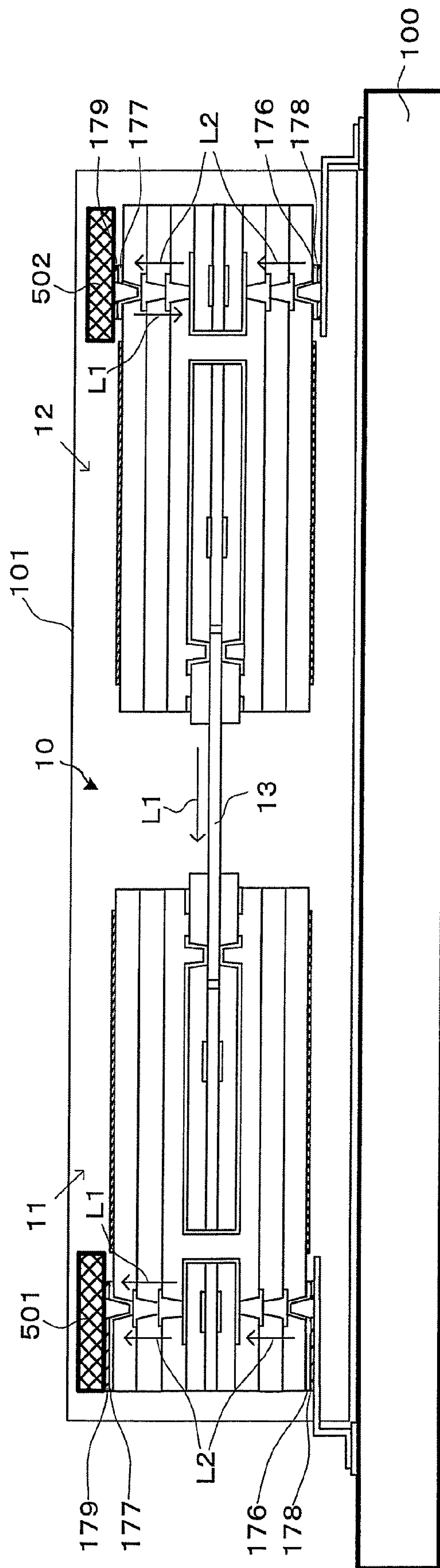
150

FIG. 4

FIG. 5



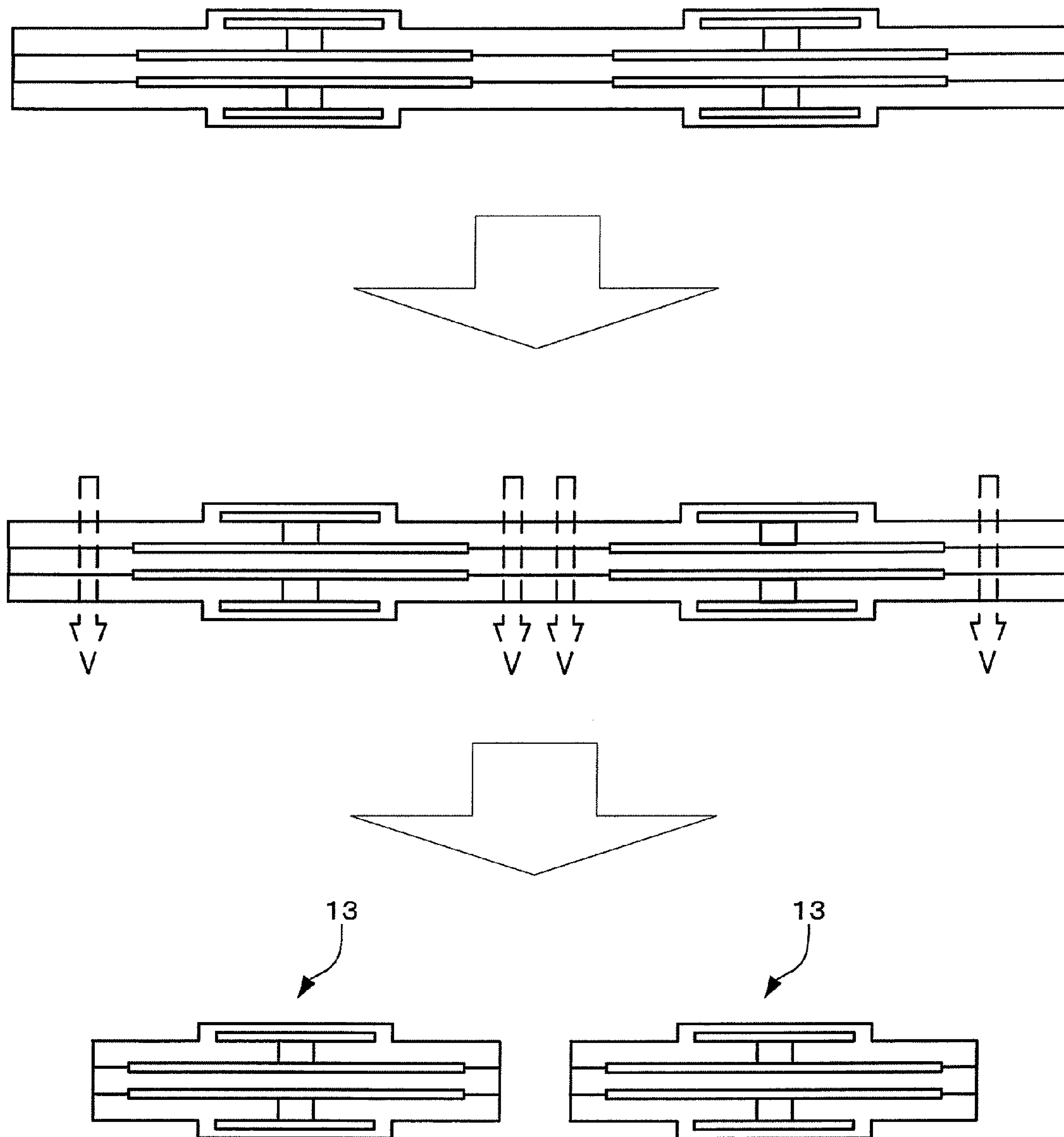


FIG. 6

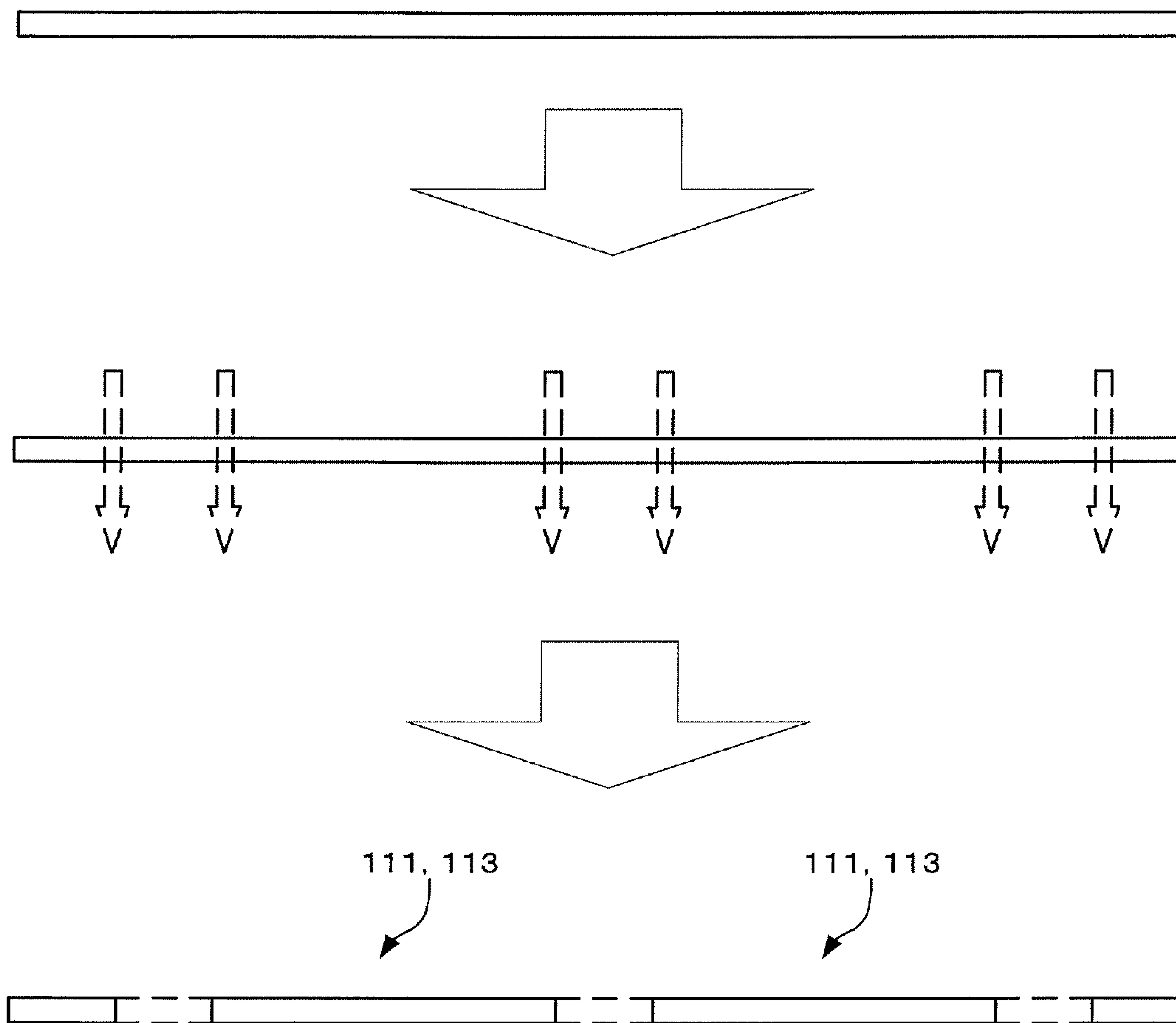


FIG. 7

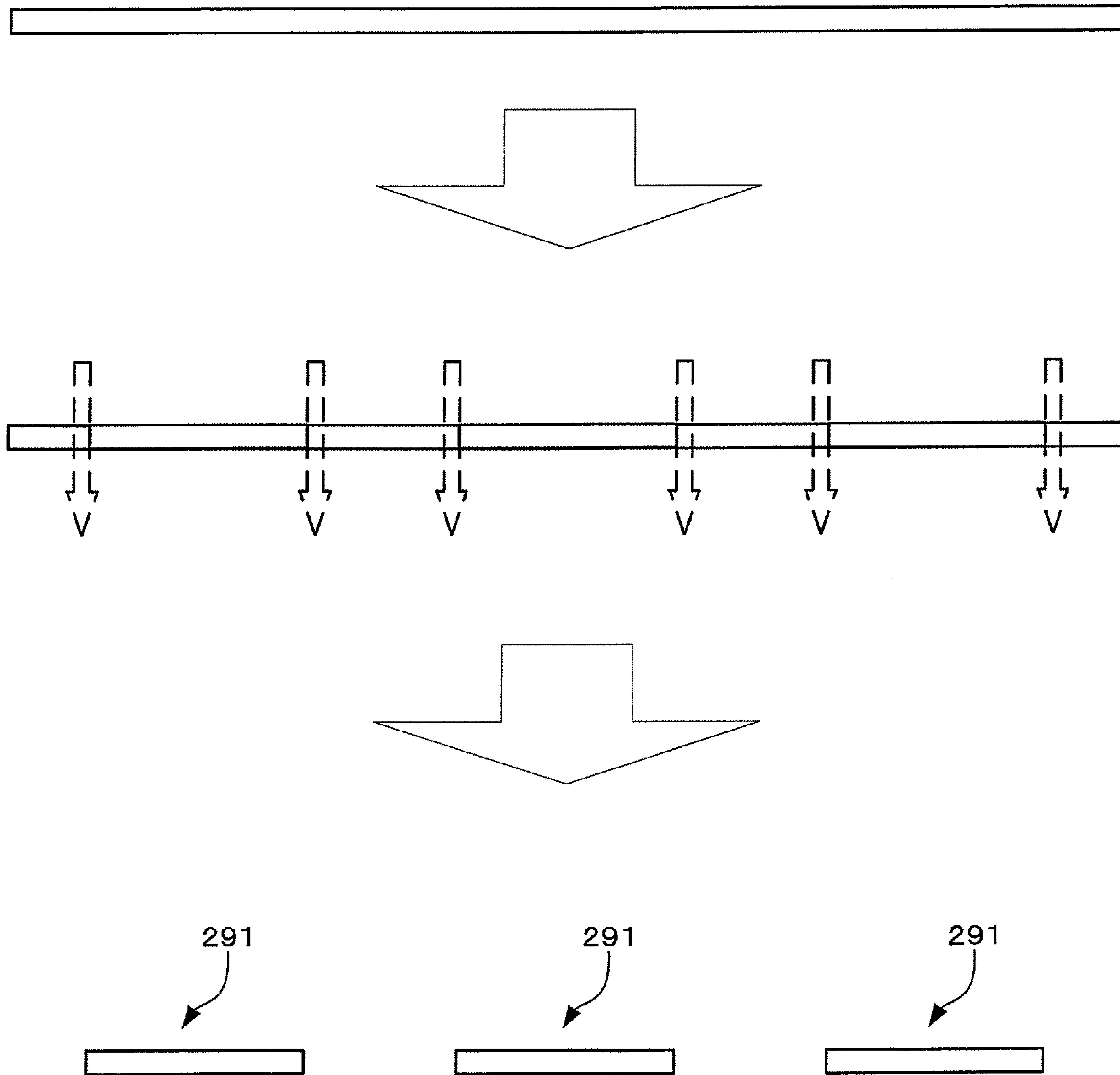


FIG. 8

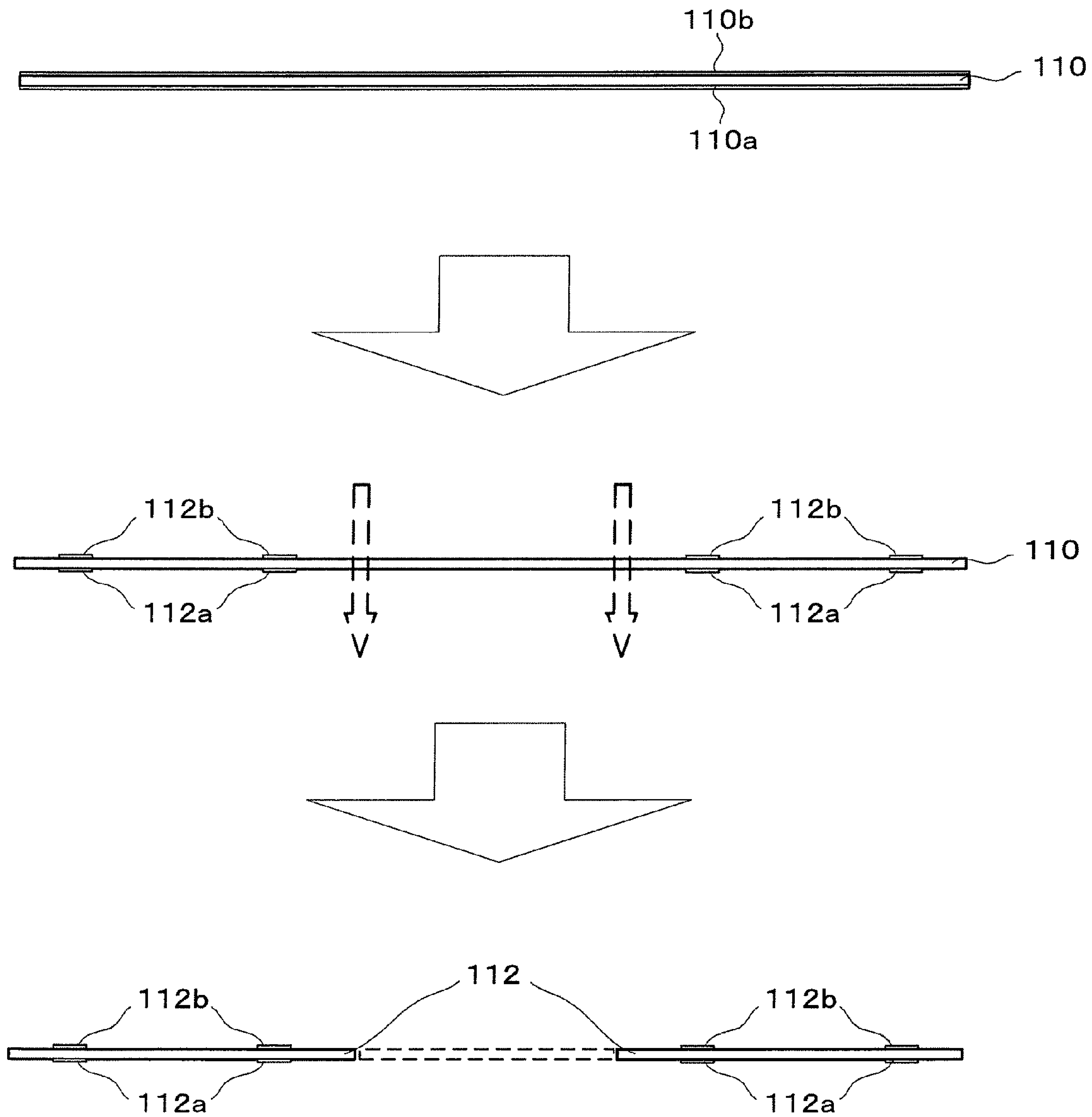


FIG. 9

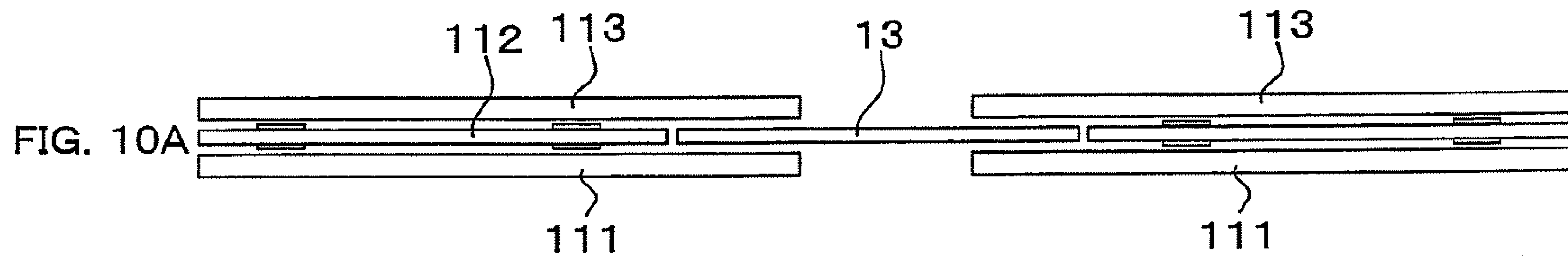


FIG. 10A
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113
13
113
111
111

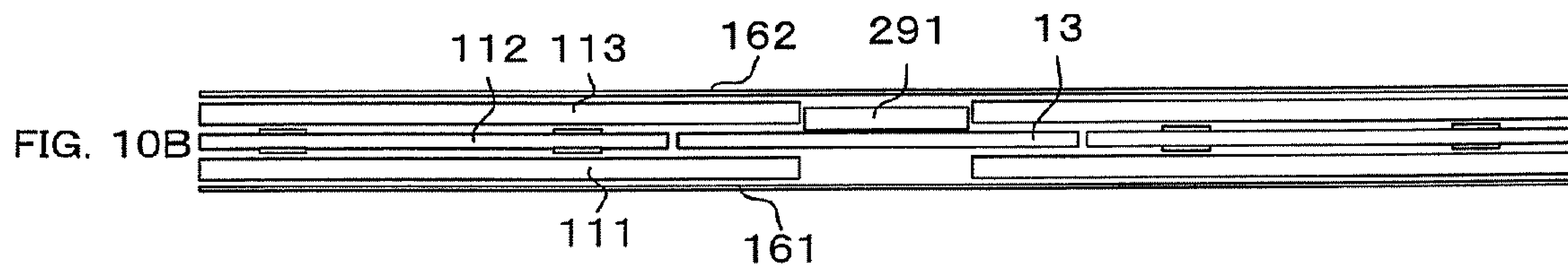


FIG. 10B
112
113
162
291
13
111
161

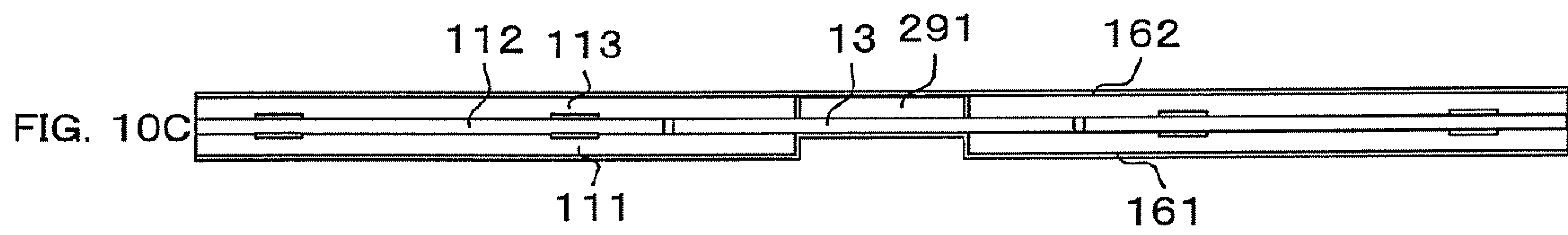


FIG. 10C
112
113
13
291
162
111
161

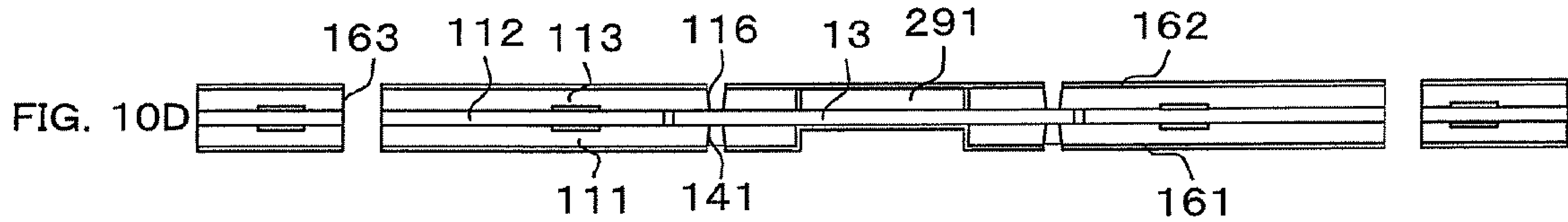


FIG. 10D
163
112
113
116
13
291
162
111
141
161

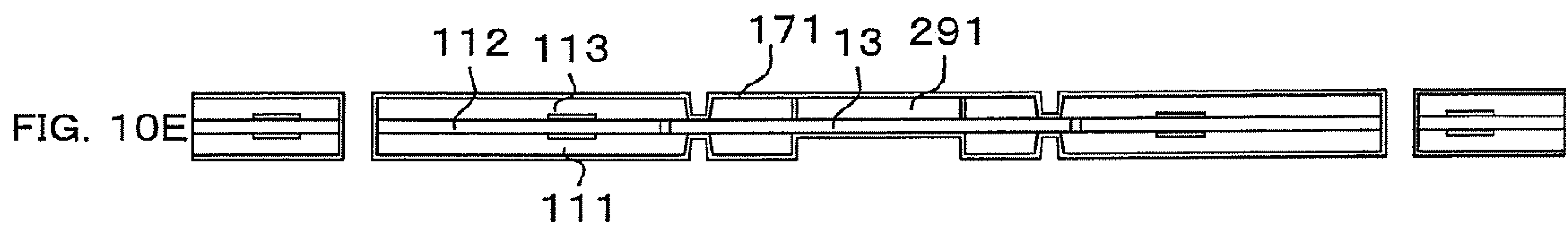


FIG. 10E
112
113
171
13
291
111

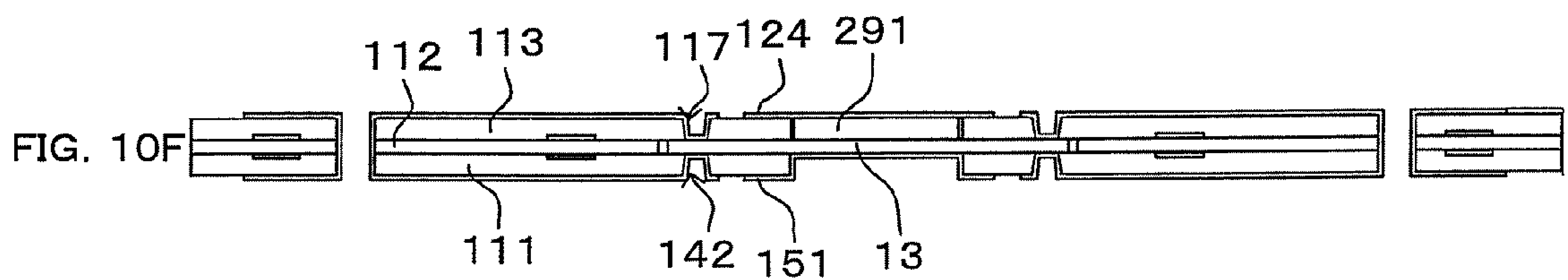


FIG. 10F
112
113
117
124
291
111
142
151
13

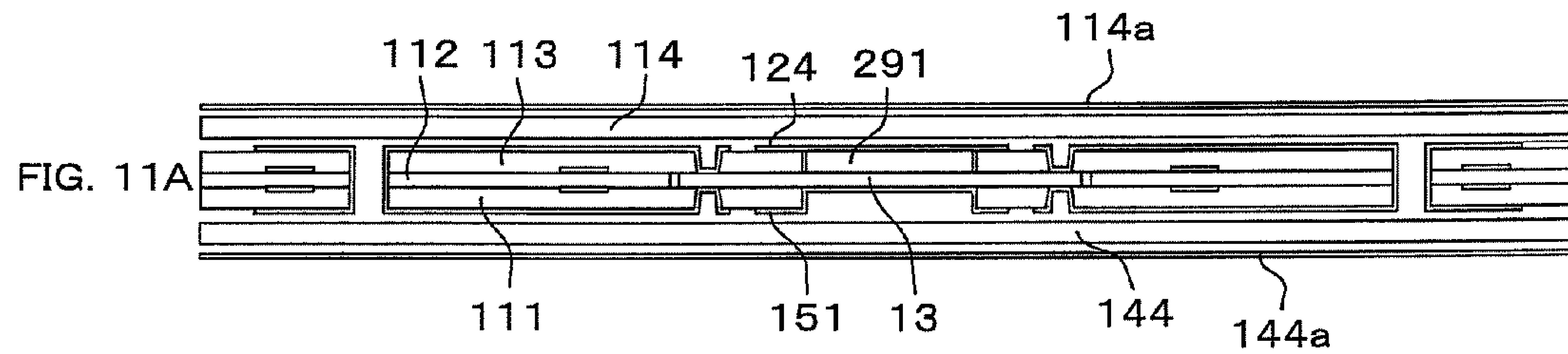


FIG. 11A
112 113 114 124 291 114a
111 151 13 144 144a

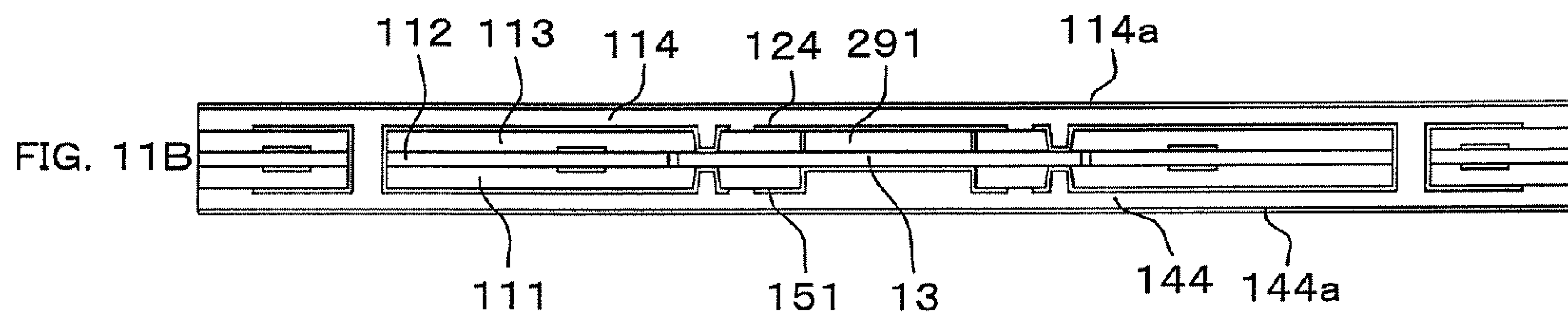


FIG. 11B
112 113 114 124 291 114a
111 151 13 144 144a

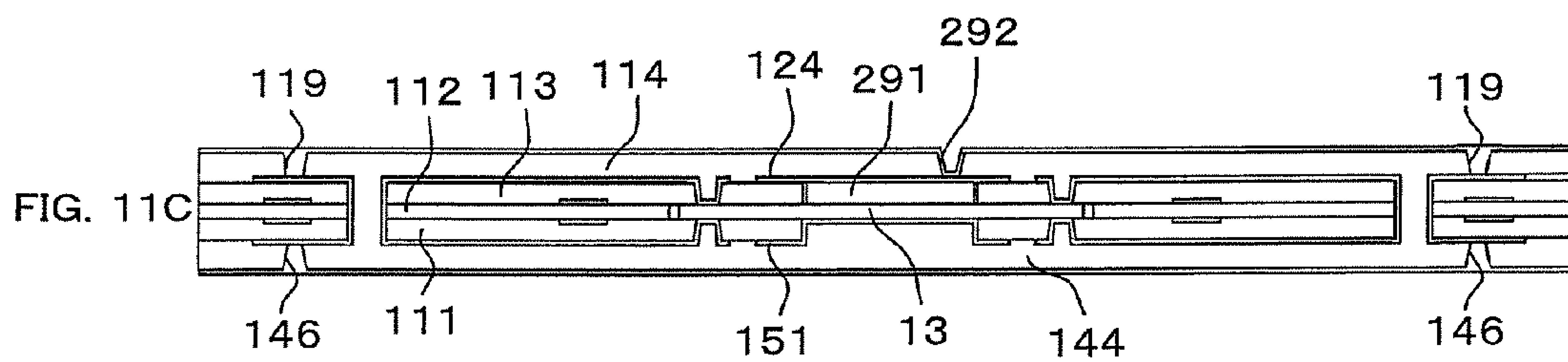


FIG. 11C
119 112 113 114 124 291 292 119
146 111 151 13 144 146

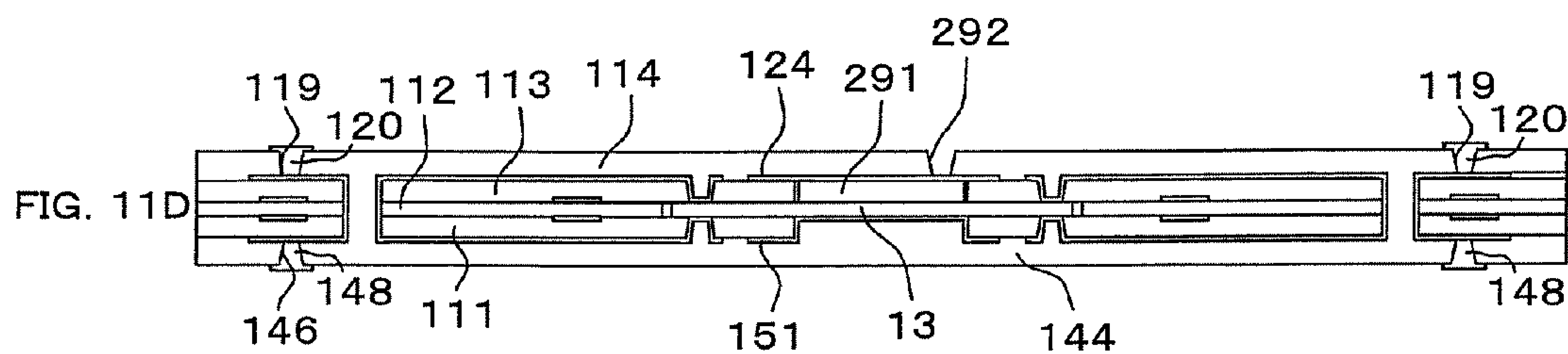


FIG. 11D
119 120 112 113 114 124 291 292 119 120
146 148 111 151 13 144 148

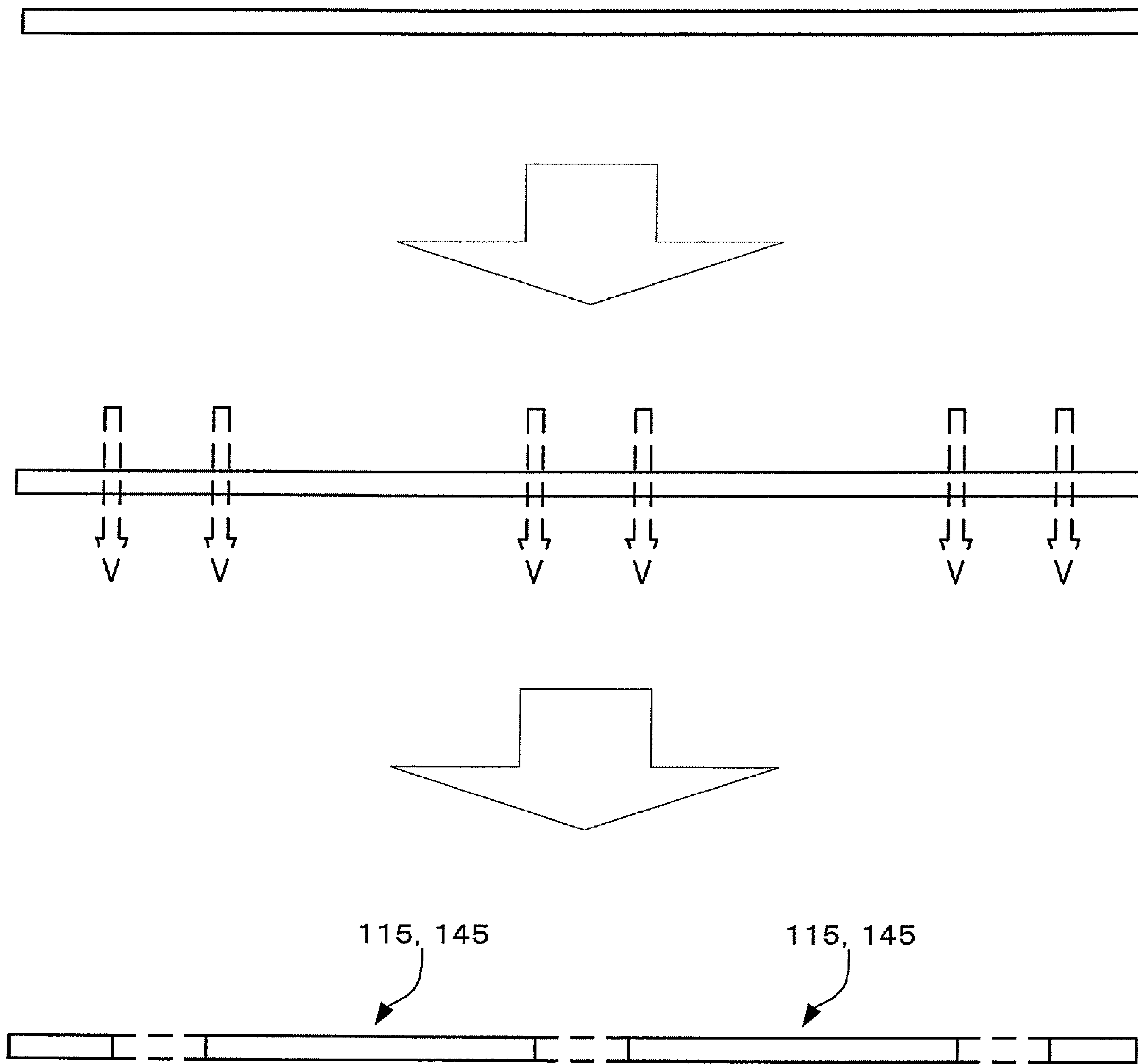


FIG. 12

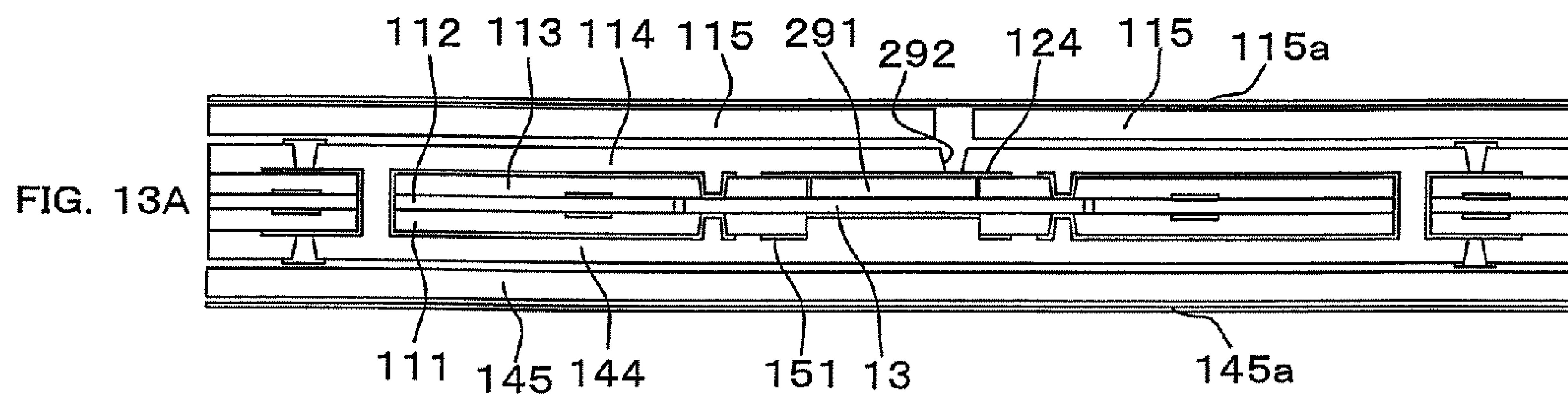


FIG. 13A

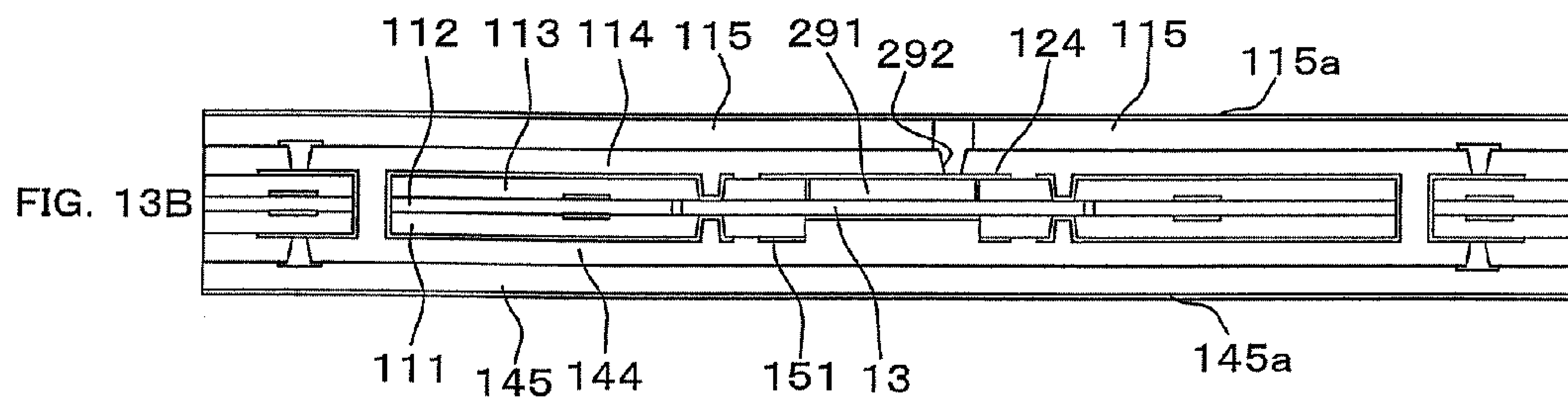


FIG. 13B

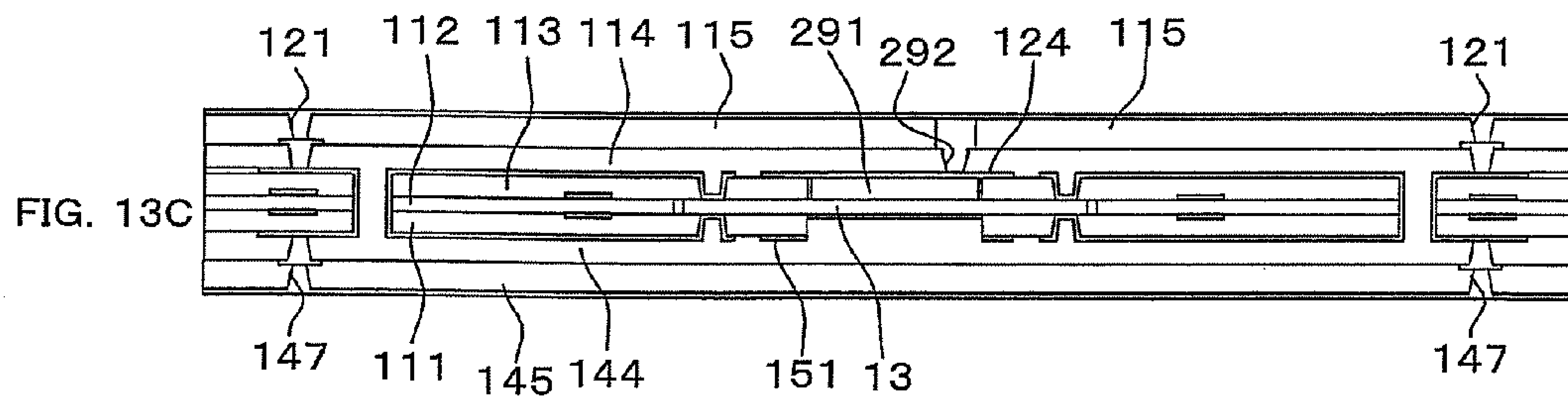


FIG. 13C

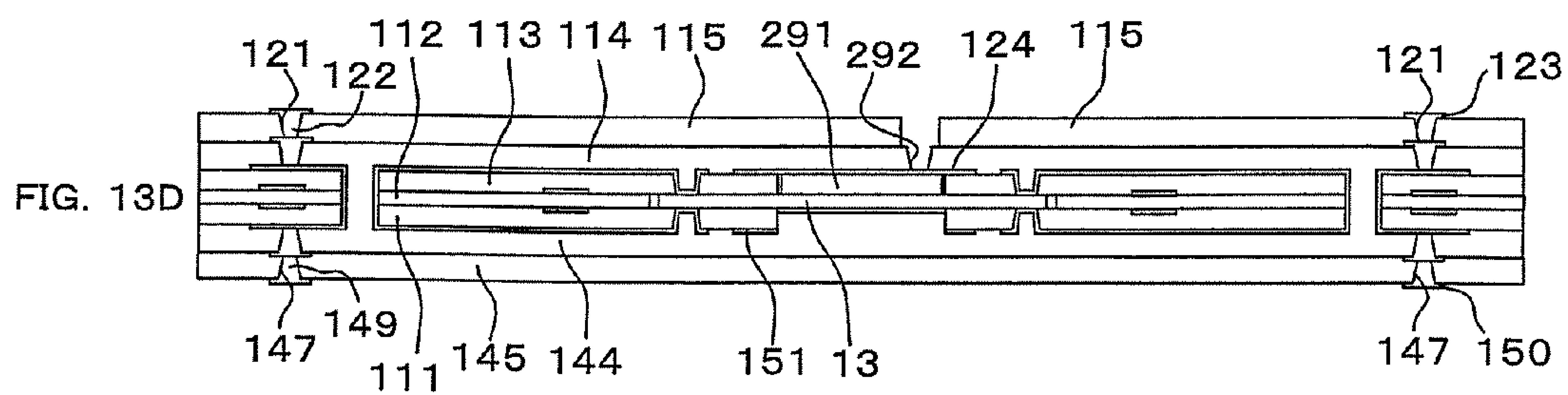


FIG. 13D

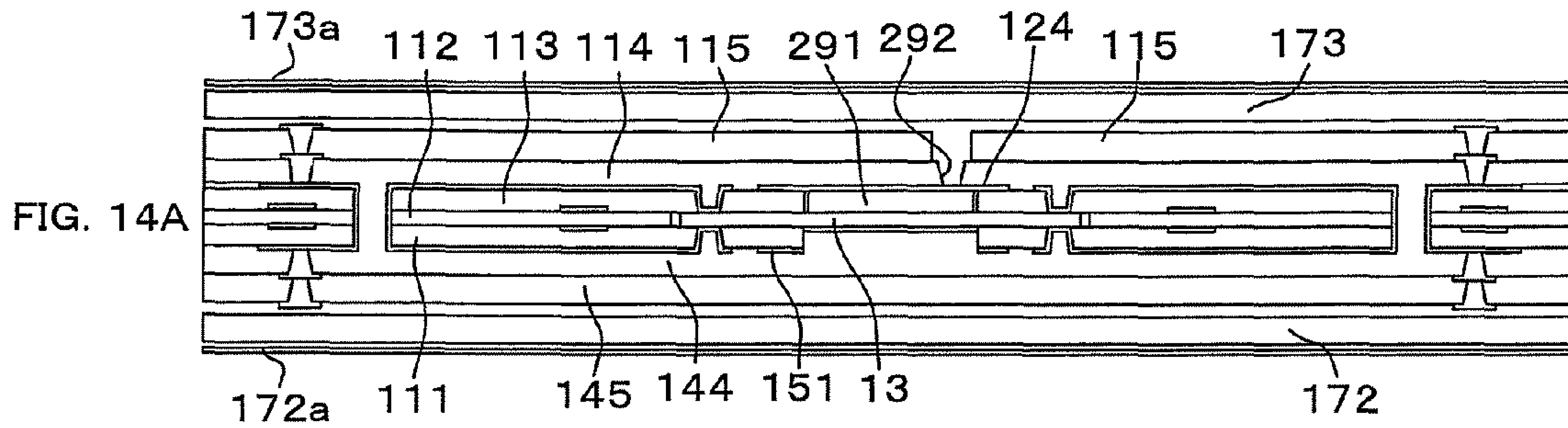


FIG. 14A

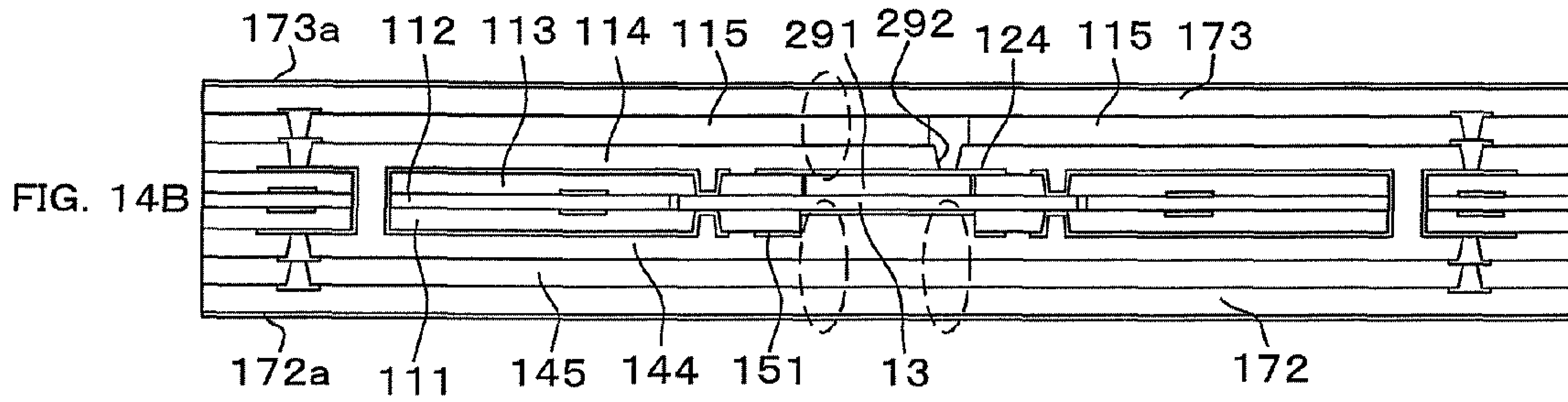


FIG. 14B

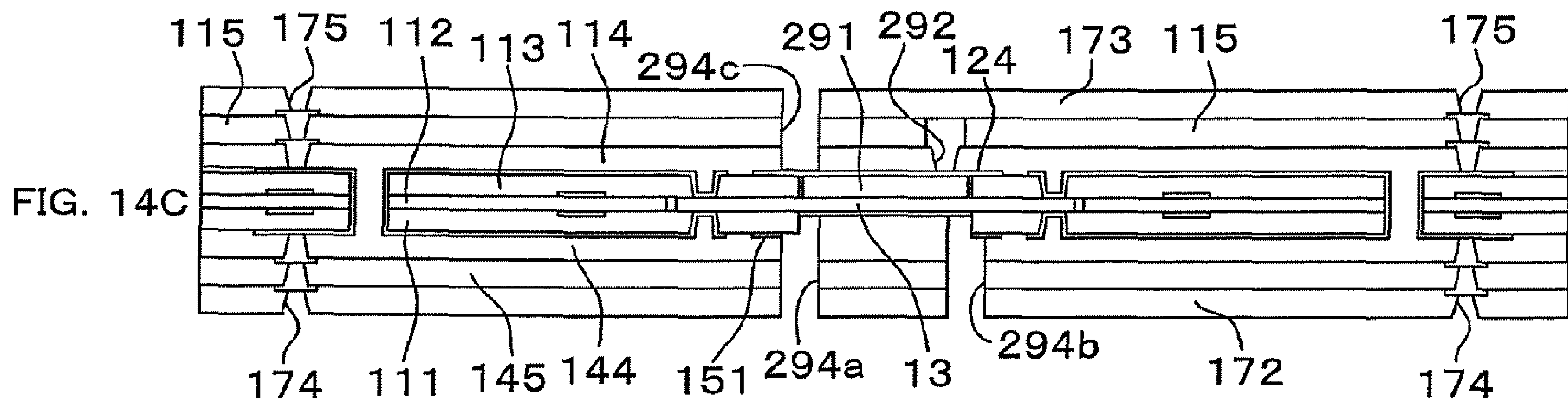


FIG. 14C

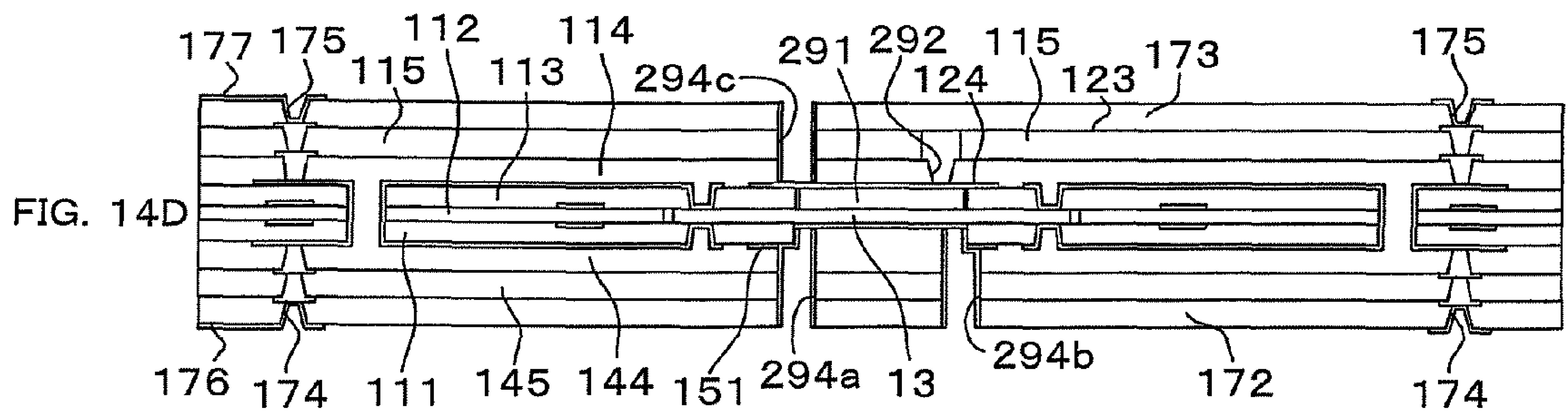


FIG. 14D

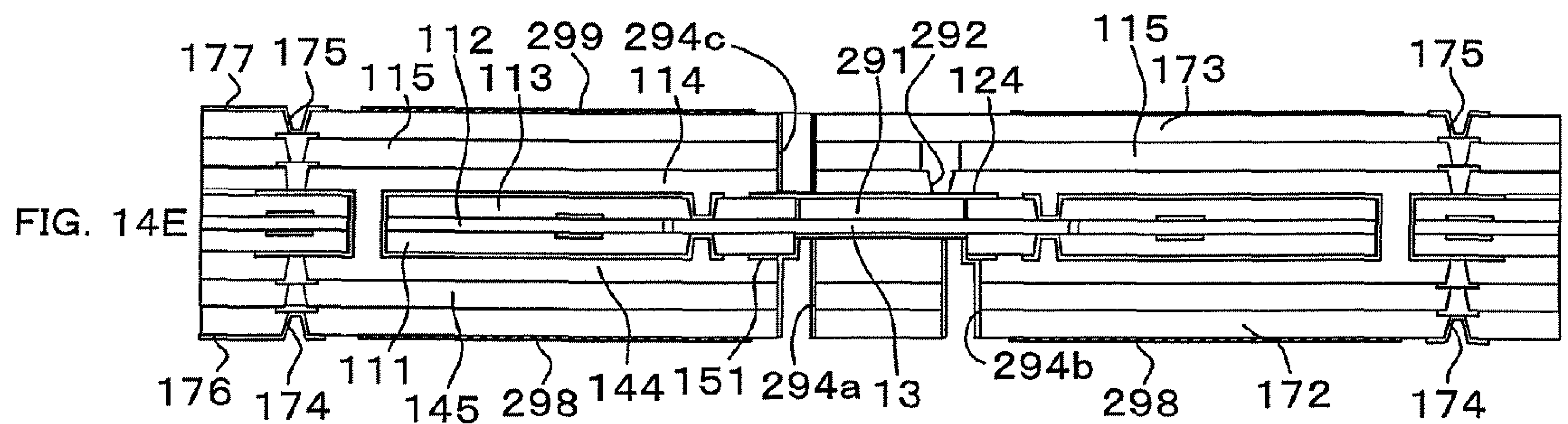
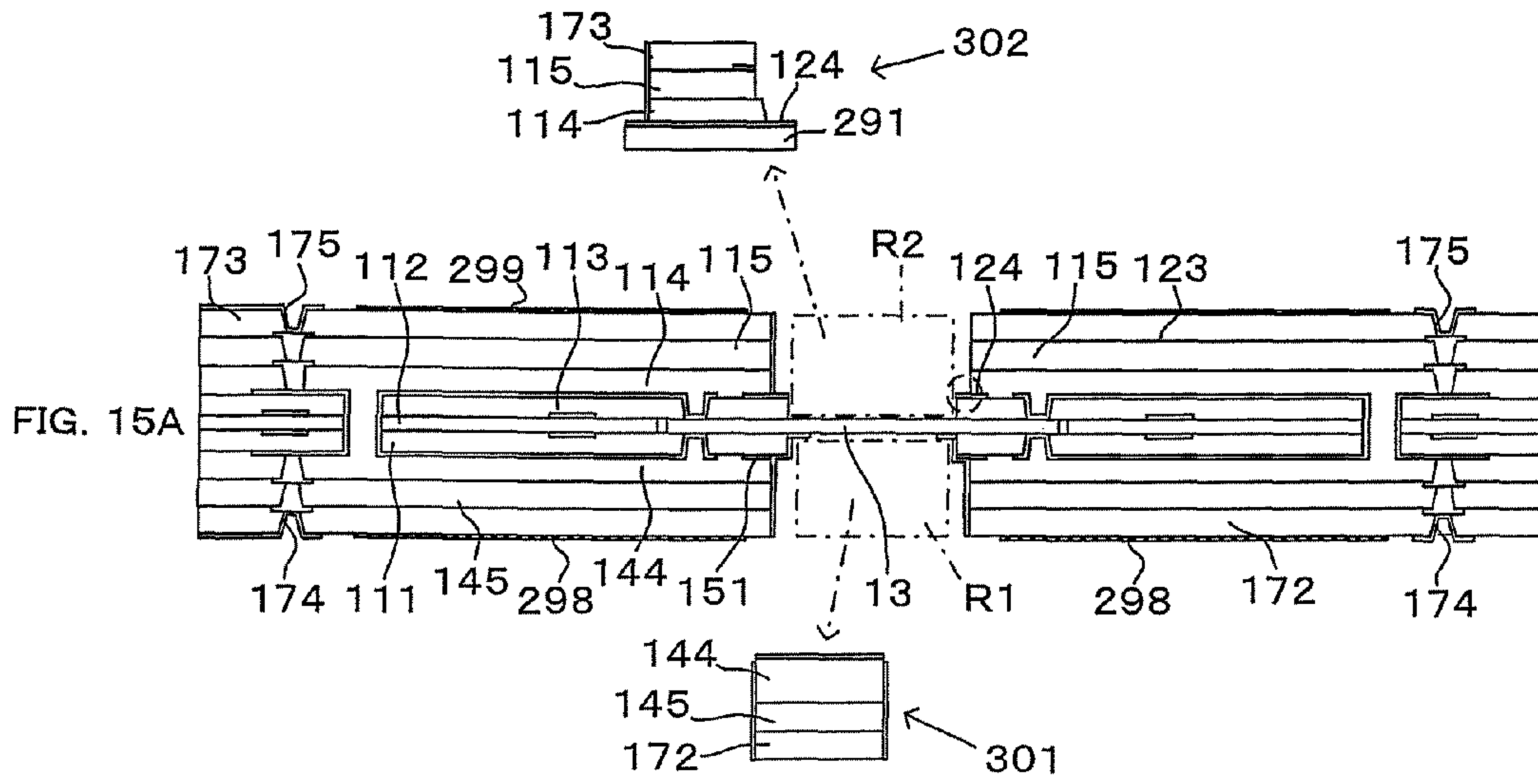


FIG. 14E


173
115
114
124
291
302
175
112
299
113
114
115
R2
124
115
123
175
FIG. 15A
174
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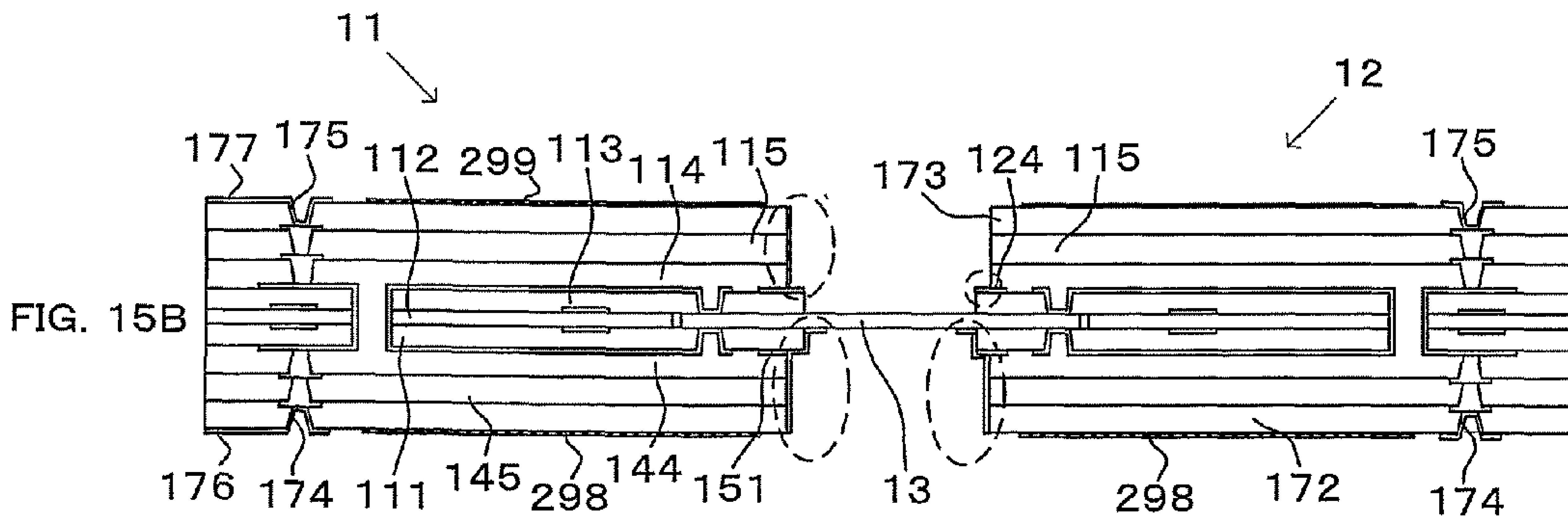
145
298
144
151
13
R1
298
172
174
144
145
172
301


11
12
177
175
112
299
113
114
115
173
124
115
175
FIG. 15B
176
174
111
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298
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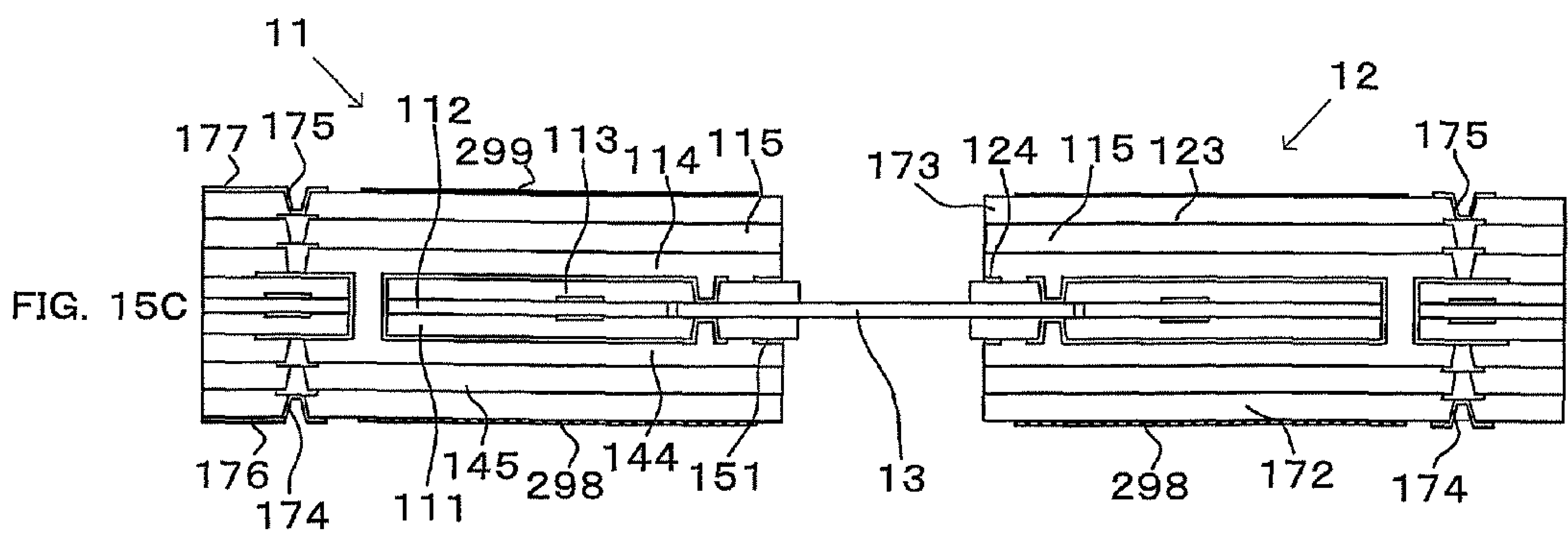
151
13
298
172
174


11
12
177
175
112
299
113
114
115
173
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123
175
FIG. 15C
176
174
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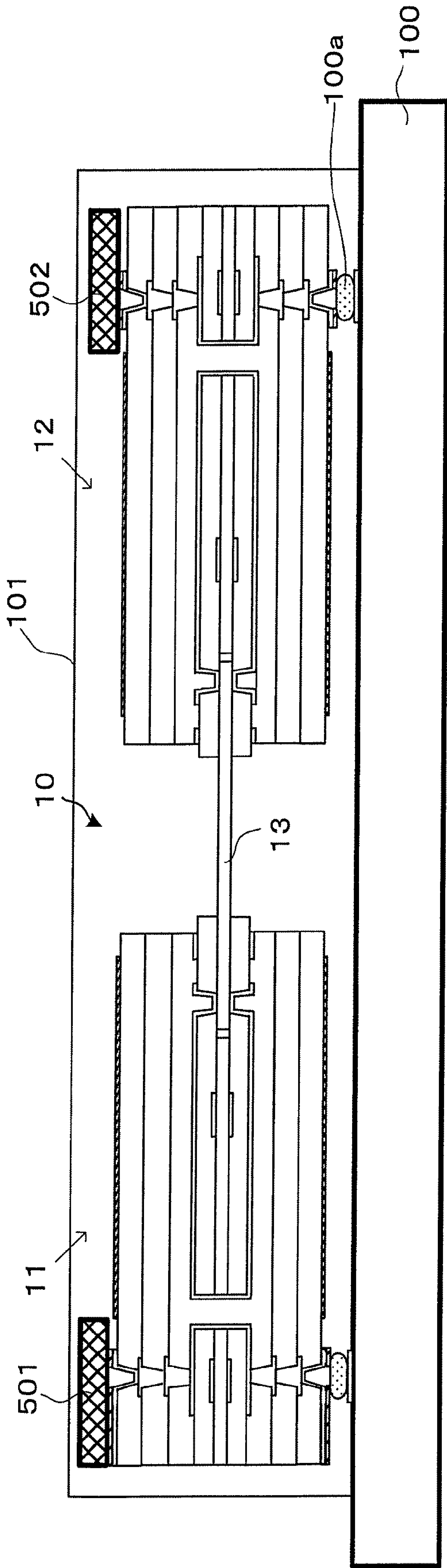
145
298
144
151
13
298
172
174

FIG. 16



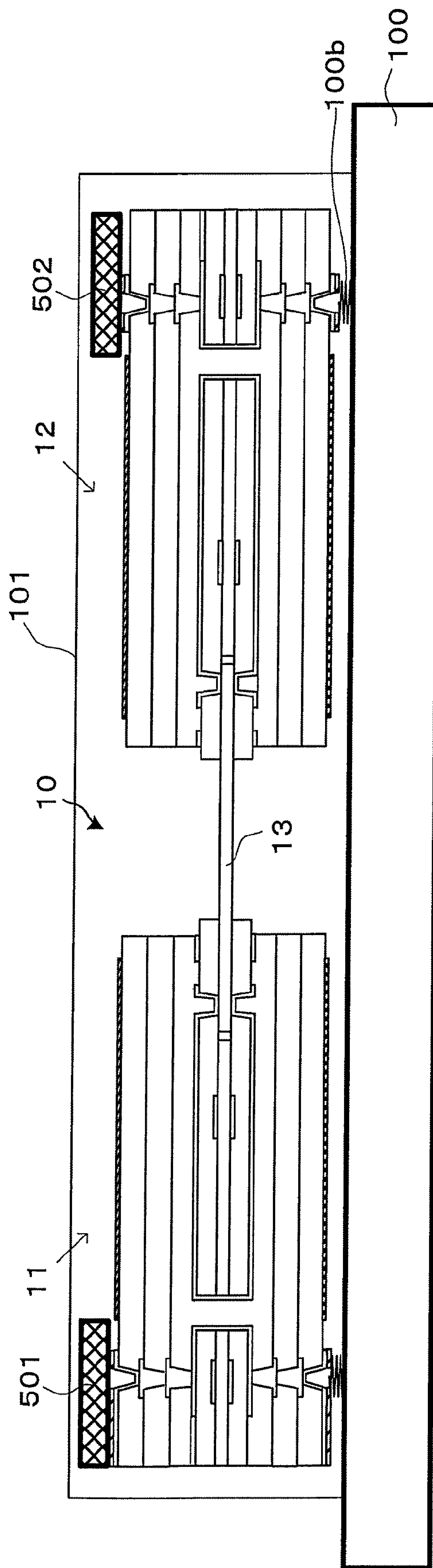
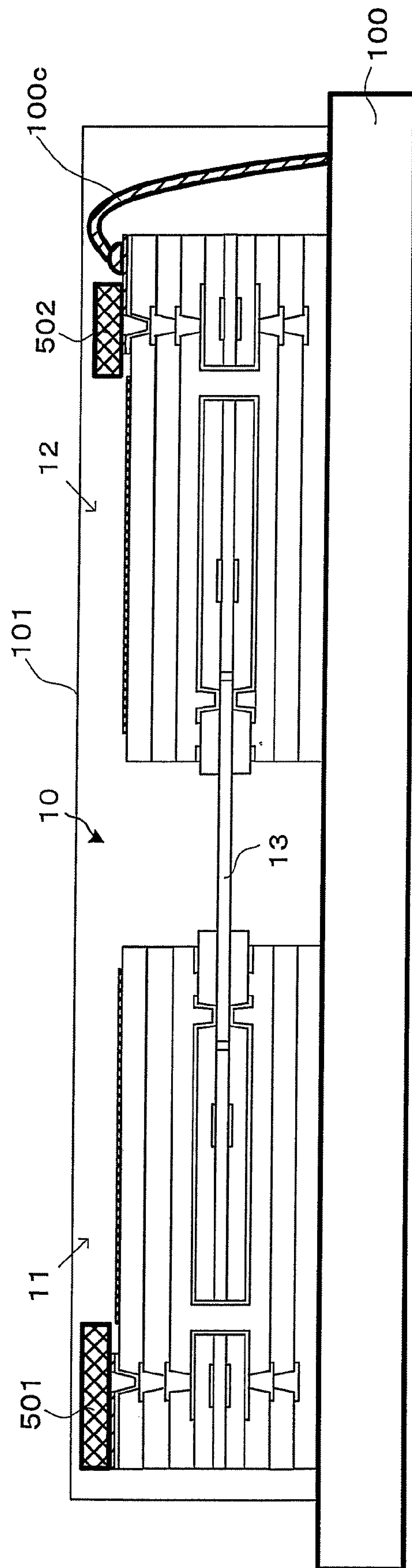


FIG. 17
100
100b
502
12
101
10
13
11
501

FIG. 18



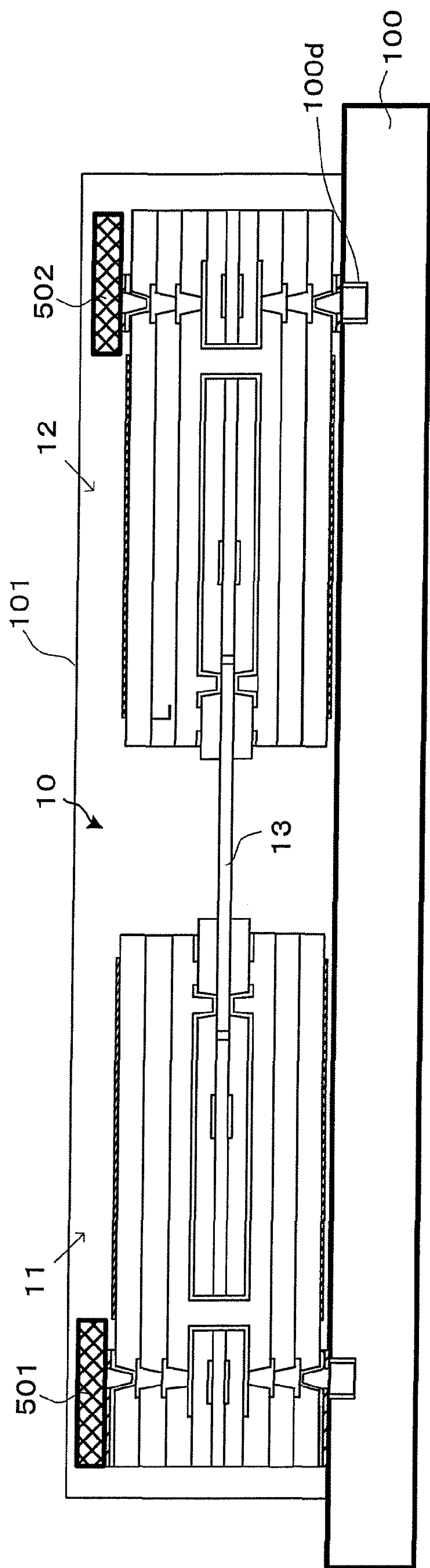


FIG. 19

FIG. 20

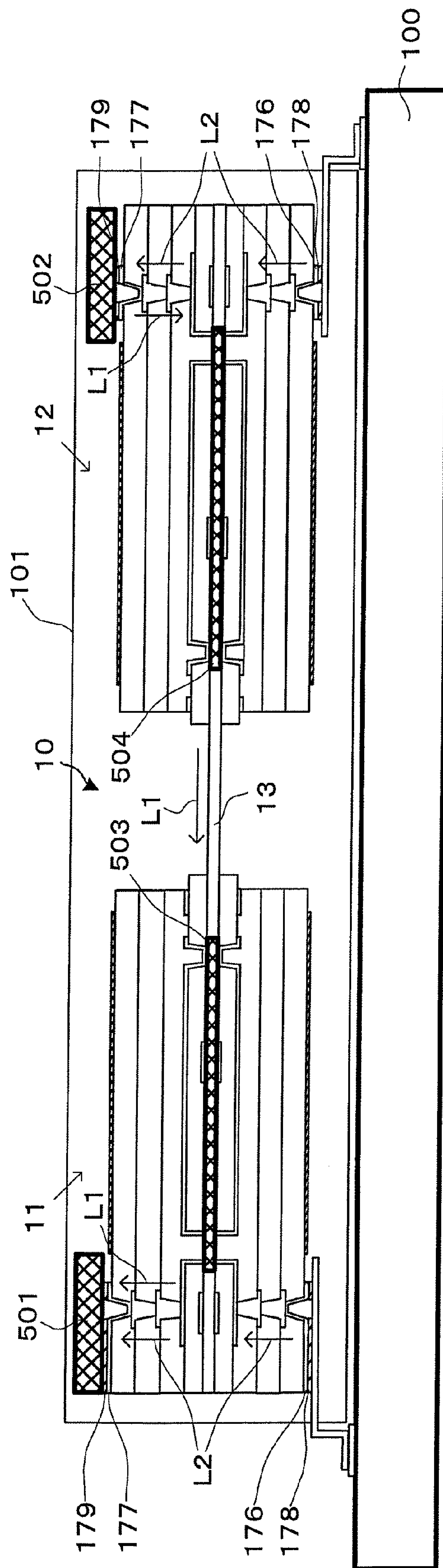


FIG. 21A

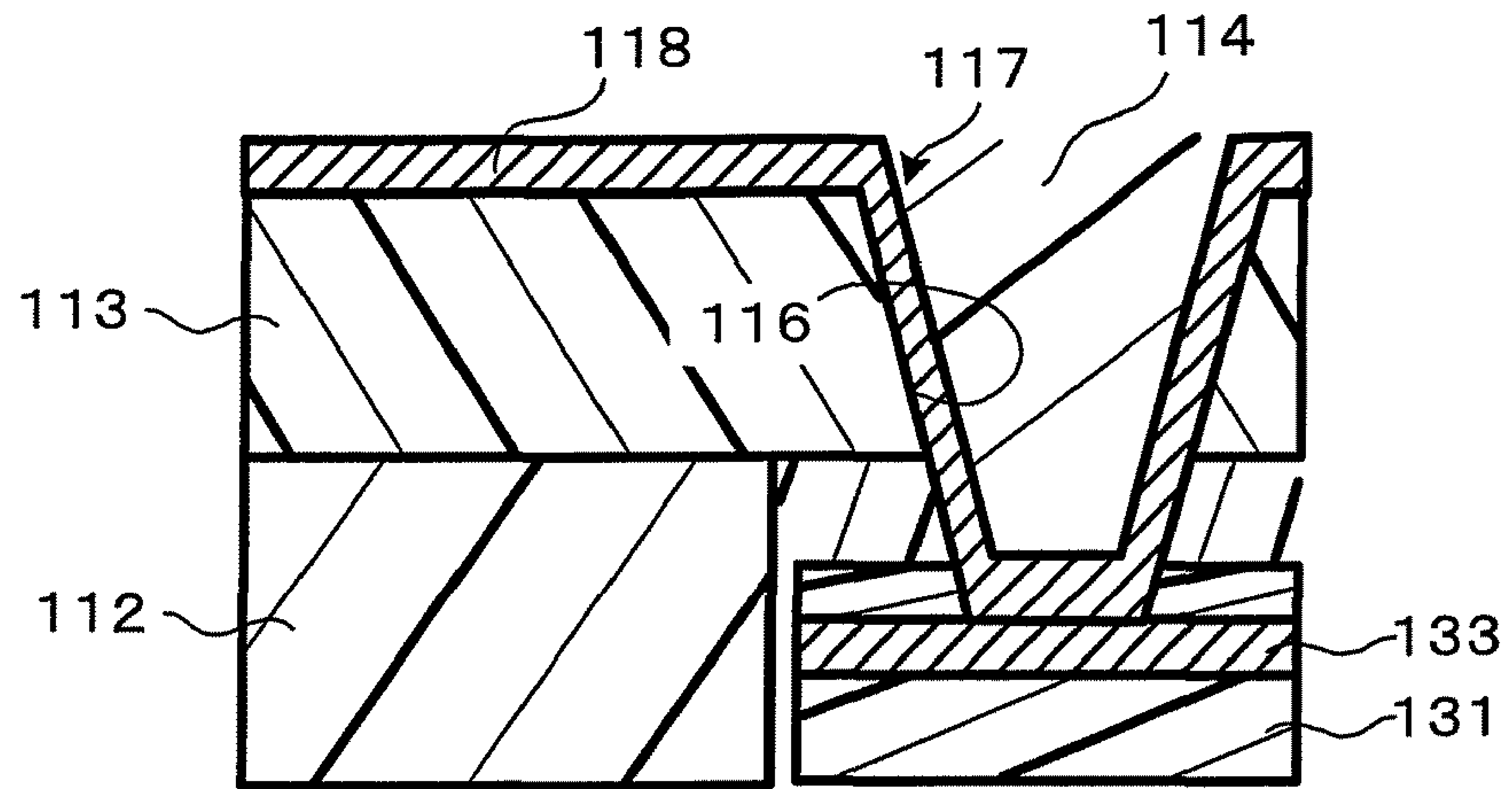


FIG. 21B

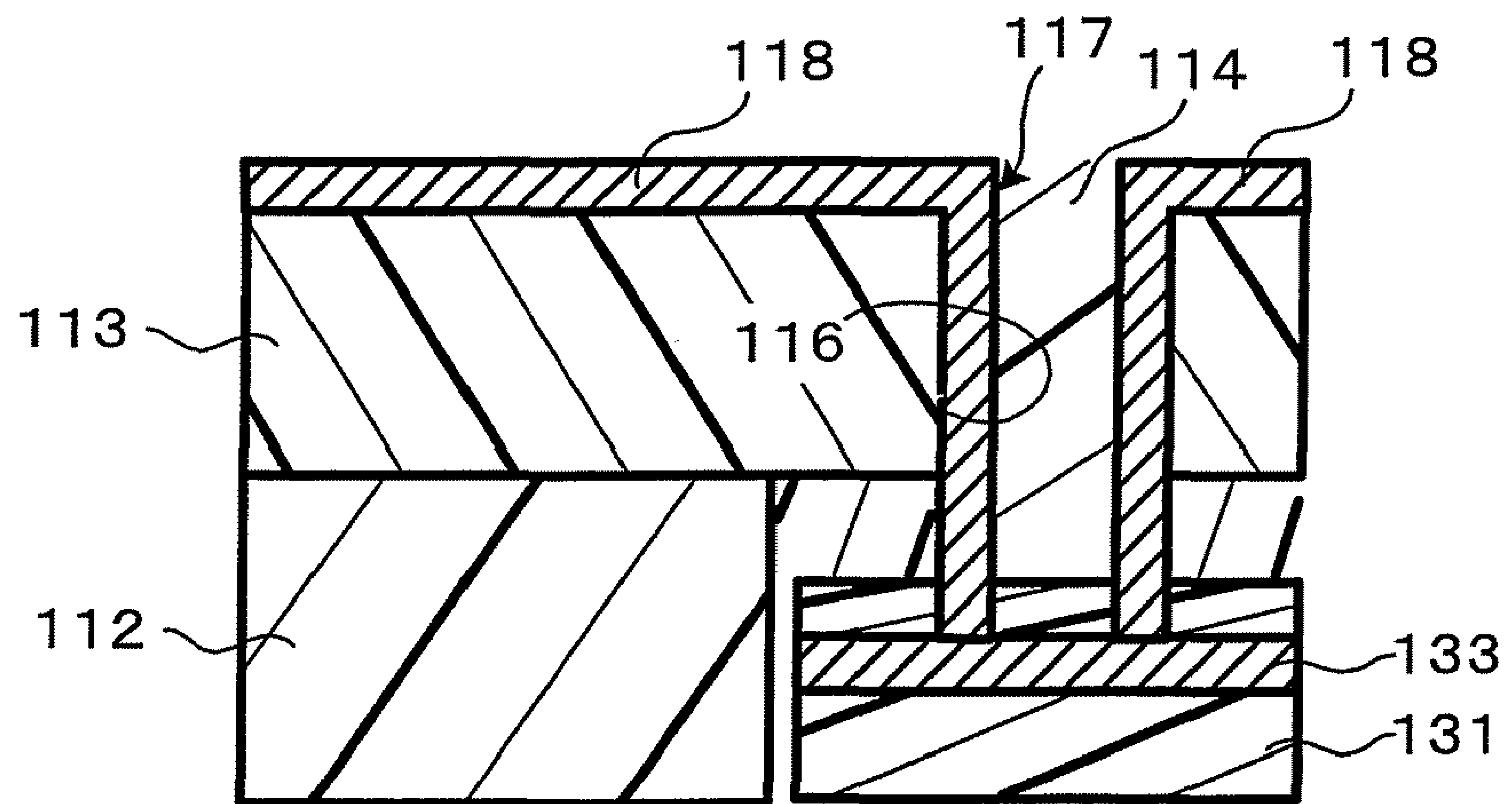
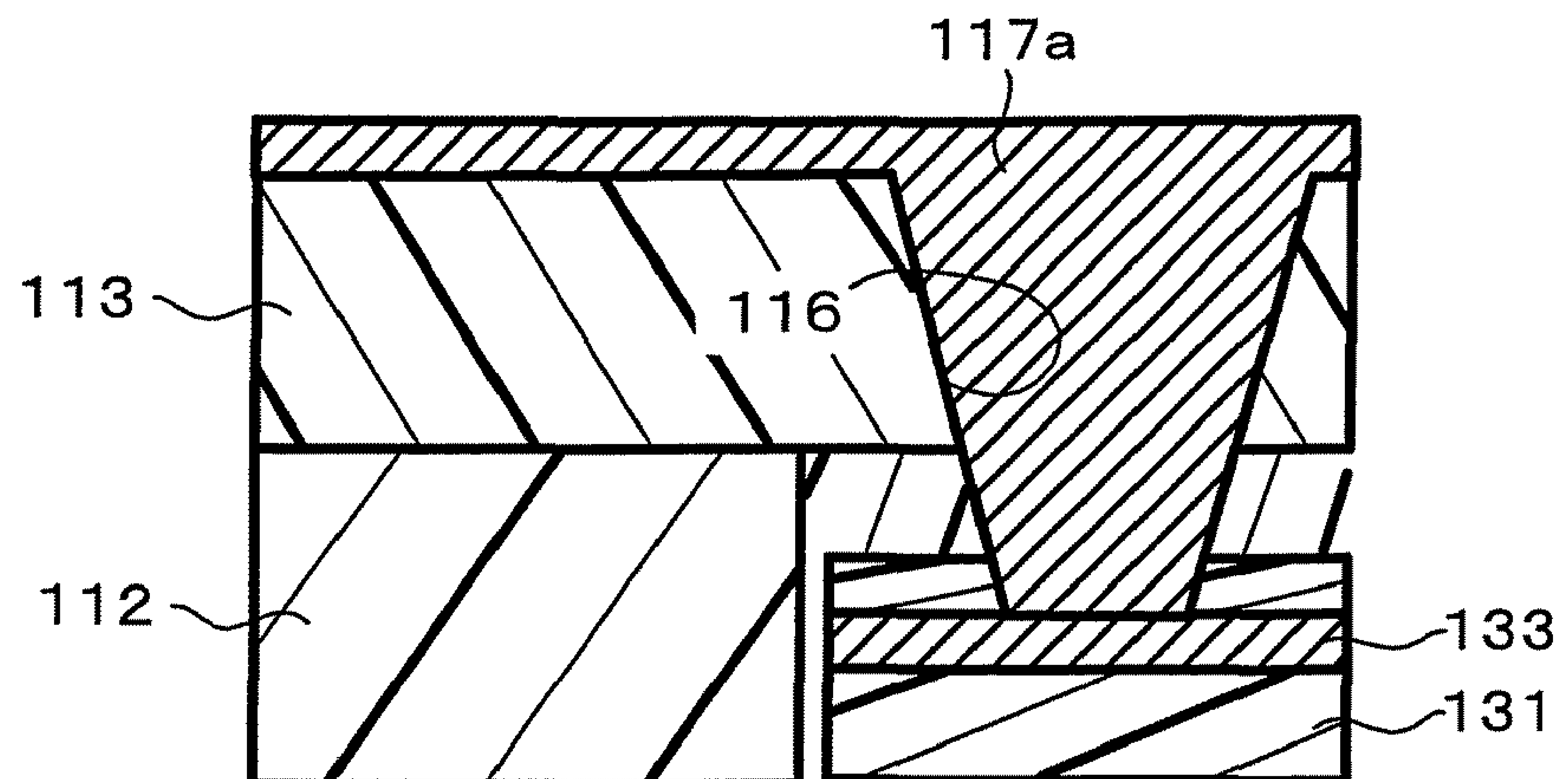


FIG. 21C



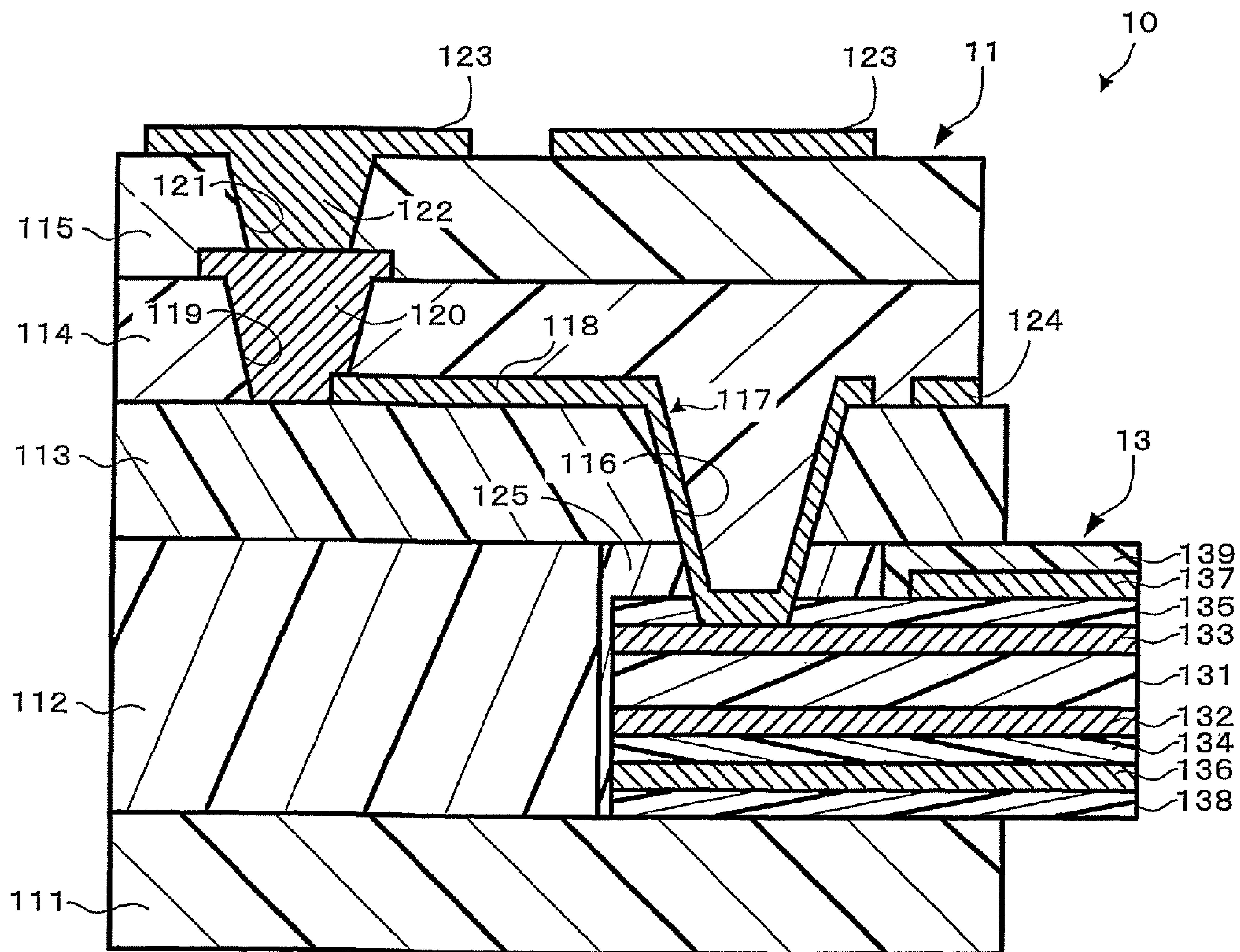


FIG. 22

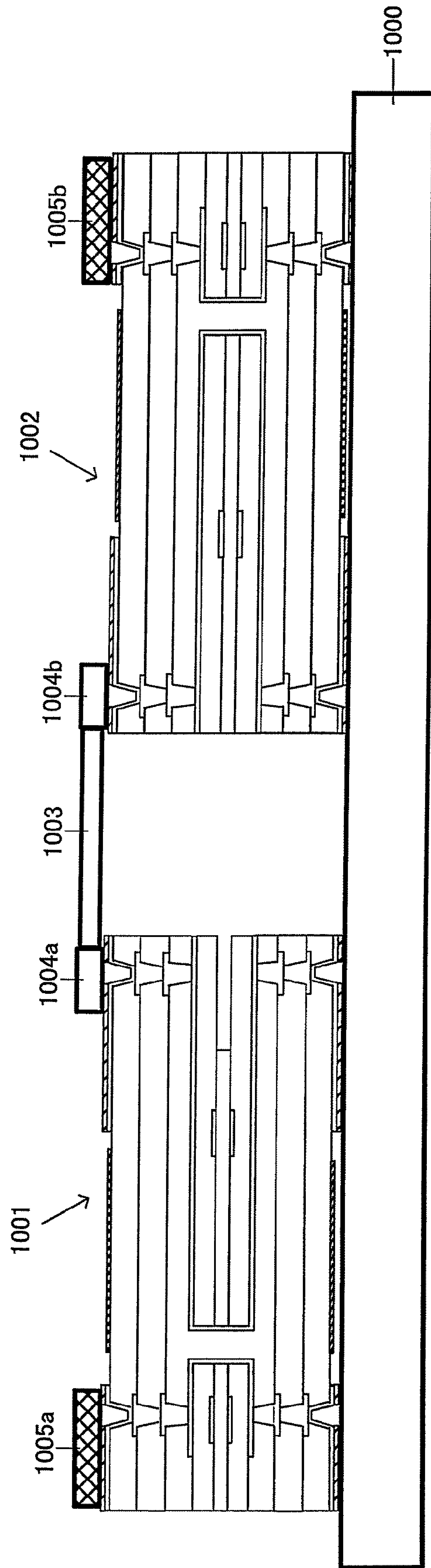


FIG. 23

FLEX-RIGID WIRING BOARD AND ELECTRONIC DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefits of priority to U.S. Application No. 61/081,176, filed Jul. 16, 2008. The contents of that application are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is related to a bendable flex-rigid wiring board, part of which is formed with a flexible substrate, and to an electronic device using the flex-rigid wiring board.

2. Discussion of the Background

Conventionally, an electronic device is known in which a rigid substrate with a mounted electronic component is sealed in packaging (PKG) of any type and is mounted on a motherboard by means of, for example, a pin connection or a soldering connection. For example, as shown in FIG. **23**, in Japanese Patent Application 2002-350974 (Publication 2004-186375), as for a structure to electrically connect multiple rigid substrates **1001**, **1002** which are mounted on motherboard **1000**, a structure (mid-air highway structure) is disclosed where flexible substrate **1003** is connected to connectors (**1004***a*, **1004***b*) arranged on the surfaces of rigid substrates **1001**, **1002** respectively, and rigid substrates **1001**, **1002** and electronic components (**1005***a*, **1005***b*) mounted on their surfaces are electrically connected with each other through flexible substrate **1003**. The contents of this publication are incorporated herein by reference in their entirety.

SUMMARY OF THE INVENTION

According to one aspect of the present invention, a flex-rigid wiring board includes a flexible printed wiring board, a rigid printed wiring board, a first connection terminal formed over the rigid printed wiring board and positioned to be mounted onto a motherboard, and a second connection terminal formed over the rigid printed wiring board and positioned to mount an electronic component. The flexible printed wiring board has a first conductive layer, the rigid printed wiring board has a rigid base material, an insulation layer over the rigid base material and a second conductive layer formed over the insulation layer. The insulation layer covers at least a portion of the flexible printed wiring board and at least a portion of the rigid base material while exposing at least a portion of the flexible printed wiring board, and the first conductive layer and the second conductive layer are connected through a plated metallic layer penetrating through the insulation layer.

According to another aspect of the present invention, an electronic device includes a motherboard and a flex-rigid wiring board mounted on a surface of the motherboard and having a flexible printed wiring board and a rigid printed wiring board. The flexible printed wiring board has a first conductive layer, the rigid printed wiring board has a rigid base material, an insulation layer over the rigid base material and a second conductive layer formed over the insulation layer, the insulation layer covers at least a portion of the flexible printed wiring board and at least a portion of the rigid base material while exposing at least a portion of the flexible printed wiring board, and the first conductive layer and the second conductive layer are connected through a plated metallic layer penetrating through the insulation layer.

According to yet another aspect of the present invention, an electronic device includes a flex-rigid wiring board having a flexible printed wiring board and a rigid printed wiring board, an electronic component mounted over a surface of the rigid printed wiring board, and a connection terminal formed over the flex-rigid wiring board and positioned to mount the flex-rigid wiring board onto a motherboard. The flexible printed wiring board has a first conductive layer, the rigid printed wiring board has a rigid base material, an insulation layer over the rigid base material and a second conductive layer formed over the insulation layer, the insulation layer covers at least a portion of the flexible printed wiring board and at least a portion of the rigid base material while exposing at least a portion of the flexible printed wiring board, and the first conductive layer and the second conductive layer are connected through a plated metallic layer penetrating through the insulation layer.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1**A is a side view of a flex-rigid wiring board according to an embodiment of the present invention;

FIG. **1**B is a plan view of a flex-rigid wiring board according to an embodiment of the present invention;

FIG. **2** is a cross-sectional view of a flexible substrate;

FIG. **3** is a cross-sectional view of a flex-rigid wiring board;

FIG. **4** is a partially enlarged view of FIG. (**1**A);

FIG. **5** is a cross-sectional view of an electronic device according to an embodiment of the present invention;

FIG. **6** are views illustrating steps to cut out flexible substrates from a wafer commonly used for multiple products;

FIG. **7** are views illustrating steps to cut out first and second insulation layers from a wafer commonly used for multiple products; working on this

FIG. **8** are views illustrating steps to cut out separators from a wafer commonly used for multiple products; working on this

FIG. **9** are views illustrating steps to produce cores for rigid substrates;

FIG. **10**A is a view illustrating a step to form a first layer;

FIG. **10**B is a view illustrating a step to form a first layer;

FIG. **10**C is a view illustrating a step to form a first layer;

FIG. **10**D is a view illustrating a step to form a first layer;

FIG. **10**E is a view illustrating a step to form a first layer;

FIG. **10**F is a view illustrating a step to form a first layer;

FIG. **11**A is a view illustrating a step to form a second layer;

FIG. **11**B is a view illustrating a step to form a second layer;

FIG. **11**C is a view illustrating a step to form a second layer;

FIG. **11**D is a view illustrating a step to form a second layer;

FIG. **12** are views illustrating steps to cut out third and fourth upper-layer insulation layers from a wafer commonly used for multiple products;

FIG. **13**A is a view illustrating a step to form a third layer;

FIG. **13**B is a view illustrating a step to form a third layer;

FIG. **13**C is a view illustrating a step to form a third layer;

FIG. **13**D is a view illustrating a step to form a third layer;

FIG. **14**A is a view illustrating a step to form a fourth layer;

FIG. **14**B is a view illustrating a step to form a fourth layer;

FIG. **14**C is a view illustrating a step to form a fourth layer;

FIG. **14**D is a view illustrating a step to form a fourth layer;

FIG. **14**E is a view illustrating a step to form a fourth layer;

FIG. **15**A is a view illustrating a step to expose part (a center portion) of a flexible substrate;

FIG. **15**B is a view showing a stage in which the center portion of the flexible substrate is exposed;

FIG. **15**C is a view showing a stage after the remaining copper is removed;

FIG. **16** is a view illustrating a modified example of the electronic device;

FIG. **17** is a view illustrating another modified example of the electronic device;

FIG. **18** is a view illustrating yet another modified example of the electronic device;

FIG. **19** is a view illustrating yet another modified example of the electronic device;

FIG. **20** is a view illustrating yet another modified example of the electronic device;

FIG. **21**A is a view showing a connection structure of between rigid substrate and a flexible substrate;

FIG. **21**B is a view showing a modified connection structure between a rigid substrate and a flexible substrate;

FIG. **21**C is a view showing another modified connection structure between a rigid substrate and a flexible substrate;

FIG. **22** is a view illustrating a modified example of the flex-rigid wiring board; and

FIG. **23** is a cross-sectional view showing an example of a flex-rigid wiring board with a mid-air highway structure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiments will now be described with reference to the accompanying drawings, wherein like reference numerals designate corresponding or identical elements throughout the various drawings.

As shown in FIGS. **1**A and **1**B, flex-rigid wiring board **10** according to the present embodiment is made up of first rigid substrate **11** and second rigid substrate **12** (both are rigid printed wiring boards) and flexible substrate **13** (flexible printed wiring board); first rigid substrate **11** and second rigid substrate **12** face each other and sandwich flexible substrate **13** in between. More specifically, first and second rigid substrates **11**, **12** are arranged horizontal to flexible substrate **13**.

In each of first and second rigid substrates **11**, **12**, a circuit pattern of any type is formed, and electronic components such as semiconductor chips or the like are connected according to requirements. Meanwhile, in flexible substrate **13**, striped wiring pattern (**13***a*) is formed to connect a circuit pattern of first rigid substrate **11** and a circuit pattern of second rigid substrate **12**. Wiring pattern (**13***a*) connects circuit patterns of rigid substrates **11**, **12** to each other.

Flexible substrate **13** has, as its detailed structure is shown in FIG. **2**, a structure made by laminating base material **131**, conductive layers **132**, **133**, insulation films **134**, **135**, shield layers **136**, **137** and coverlays **138**, **139**.

Base material **131** is formed with an insulative flexible sheet, for example, a polyimide sheet, with a thickness in the range of 20-50 μm, preferably with an approximate thickness of 30 μm.

Conductive layers **132**, **133** are made of a copper pattern with an approximate thickness of 5-15 μm; they are formed on the front and back, respectively, of base material **131** to structure the above-described striped wiring pattern (**13***a*) (FIG. **1**B).

Insulation films **134**, **135** are made with a polyimide film or the like with an approximate thickness of 5-15 μm, and insulate conductive layers **132**, **133** from the outside.

Shield layers **136**, **137** are made with a conductive layer, for example, a cured silver paste film, and shield conductive layers **132**, **133** from external electromagnetic noise, and shield the electromagnetic noise from conductive layers **132**, **133** from going outside.

Coverlays **138**, **139** are made with an insulative film such as polyimide with an approximate thickness of 5-15 μm; they insulate and protect the entire flexible substrate **13** from the outside.

On the other hand, rigid substrates **11**, **12**, as is shown in FIG. **3**, each are formed by laminating rigid base material **112**, first and second insulation layers **111**, **113**, first and second upper-layer insulation layers **144**, **114**, third and fourth upper-layer insulation layers **145**, **115**, and fifth and sixth upper-layer insulation layers **172**, **173**.

Rigid base material **112** provides rigidity for rigid substrates **11**, **12** and is formed with a rigid insulative material such as glass epoxy resin. Rigid base material **112** is arranged horizontal to flexible substrate **13** without touching it. Rigid base material **112** has substantially the same thickness as flexible substrate **13**. Also, on the front and back of rigid base material **112**, conductive patterns (**112***a*, **112***b*) made of copper, for example, are formed respectively. Conductive patterns (**112***a*, **112***b*) are each electrically connected to a further upper-layer conductor (wiring) at a predetermined spot.

First and second insulation layers **111**, **113** are formed by curing a prepreg. First and second insulation layers **111**, **113** each have a thickness in the range of 50-100 μm, preferably an approximate thickness of 50 μm. The prepreg is preferred to contain a resin with low-flow characteristics. Such a prepreg may be formed by impregnating a glass cloth with epoxy resin and by thermosetting the resin beforehand to advance its degree of curing. However, such a prepreg may also be made by impregnating a glass cloth with a highly viscous resin, or by impregnating a glass cloth with inorganic filler (such as silica filler), or by reducing the resin amount to be impregnated in a glass cloth.

Rigid base material **112** and first and second insulation layers **111**, **113** form the core for rigid substrates **11**, **12** and support rigid substrates **11**, **12**. In the core section, through-holes (penetrating holes) **163** are formed to electrically interconnect the conductive patterns on both surfaces of the substrate.

Rigid substrates **11**, **12** and flexible substrate **13** are connected at the core sections of rigid substrates **11**, **12** respectively. First and second insulation layers **111**, **113** support and anchor flexible substrate **13** by sandwiching its tips. Specifically, as FIG. **4** shows an enlarged view of region (R**11**) (the connected section between first rigid substrate **11** and flexible substrate **13**) shown in FIG. **1**A, first and second insulation layers **111**, **113** cover rigid base material **112** and flexible substrate **13** from the top and back sides while exposing part of flexible substrate **13**. First and second insulation layers **111**, **113** are polymerized with coverlays **138**, **139** formed on the surfaces of flexible substrate **13**.

The structure of the connection section between rigid substrate **12** and flexible substrate **13** is the same as the structure (FIG. **4**) of the connection section between rigid substrate **11** and flexible substrate **13**. Therefore, the detailed description of the connection section of rigid substrate **12** is omitted here.

In the spaces (gaps among such members) sectioned off by rigid base material **112**, flexible substrate **13** and first and second insulation layers **111**, **113**, resin **125** is filled as shown in FIG. **4**. Resin **125** is a kind of resin, for example, that seeps

from the low-flow prepreg which forms first and second insulation layers **111**, **113** during the manufacturing process and is cured to be integrated with first and second insulation layers **111**, **113**.

At the portions of first and second insulation layers **111**, **113** facing connection pads (**13***b*) on conductive layers **132**, **133** of flexible substrate **13**, vias (contact holes) **141**, **116** are formed respectively. From each portion of flexible substrate **13** facing vias **141**, **116** (the portion where connection pad (**13***b*) is formed as shown in FIG. **1**B), shield layers **136**, **137** and coverlays **138**, **139** of flexible substrate **13** are removed. Vias **141**, **116** penetrate insulation layers **134**, **135** of flexible substrate **13** respectively, and expose each connection pad (**13***b*) formed from conductive layers **132**, **133**.

On each inner surface of vias **141**, **116**, wiring patterns (conductive layers) **142**, **117** made of copper plating or the like are formed respectively. The plated metallic layers of wiring patterns **142**, **117** are connected respectively to connection pads (**13***b*) on conductive layers **132**, **133** of flexible substrate **13**. In vias **141**, **116**, resin is filled. The resin in vias **141**, **116** is filled by being squeezed from the upper-layer insulation layers (upper-layer insulation layers **144**, **114**) by pressing, for example. Furthermore, on each top surface of first and second insulation layers **111**, **113**, extended patterns **143**, **118**, which are connected to wiring patterns **142**, **117**, are formed respectively. Extended patterns **143**, **118** are formed with, for example, a copper-plated layer. Also, at the tips of first and second insulation layers **111**, **113** on the side of flexible substrate **13**, namely, at the areas of flexible substrate **13** that are positioned outside the boundary between flexible substrate **13** and rigid base material **112**, conductive patterns **151**, **124** insulated from the rest are arranged respectively. Heat generated in rigid substrate **11** is effectively radiated through conductive patterns **151**, **124**.

As described so far, in flex-rigid wiring board **10** according to the present embodiment, rigid substrates **11**, **12** and flexible substrate **13** are electrically connected without using connectors. Namely, flexible substrate **13** is inserted in rigid substrates **11**, **12** respectively, and flexible substrate **13** is electrically connected to each rigid substrate at the inserted portion (see FIG. **4**). Accordingly, even when an impact from being dropped or the like is exerted, poor connection due to disconnected connectors will not occur. In this sense, flex-rigid wiring board **10** features highly reliable electrical connection, compared with a substrate where connection is achieved through connectors.

Also, since flexible substrate **13** is used for connection, connectors or jigs are not required to connect rigid substrates **11**, **12**. Accordingly, a reduction in manufacturing cost may be achieved.

Also, flexible substrate **13** is made up partially of a flex-rigid wiring board, and part of it is embedded in rigid substrates **11**, **12** respectively. Therefore, without making a substantial change in the design of rigid substrates **11**, **12**, both substrates **11**, **12** may be electrically connected to each other. Moreover, since the connection is carried out inside the substrates, larger mounting areas are secured on the surfaces of the substrates compared with the above-described mid-air highway structure. Accordingly, more electronic components may be mounted.

In addition, conductive layers **132**, **133** of flexible substrate **13** and wiring patterns **142**, **117** of rigid substrates **11**, **12** are connected through taper-shaped vias. Thus, compared with a connection by means of through-holes which extend in a direction that makes a right angle to the substrate surface, stresses exerted from impact may be dispersed and thus cracks or the like may seldom occur. Moreover, since conductive layers **132**, **133** and wiring patterns **142**, **117** are connected through plated metallic layers, reliability at the connected areas is high. Besides, resin is filled in vias **141**, **116**, further increasing connection reliability.

On the top surfaces of first and second insulation layers **111**, **113**, first and second upper-layer insulation layers **144**, **114** are laminated respectively. In first and second upper-layer insulation layers **144**, **114**, vias (first upper-layer vias) **146**, **119** connected to extended patterns **143**, **118** are formed respectively. In addition, vias **146**, **119** are filled respectively with conductors **148**, **120** made of copper, for example. First and second upper-layer insulation layers **144**, **114** are formed by curing a prepreg made, for example, by impregnating glass cloth with resin.

On the top surfaces of first and second upper-layer insulation layers **144**, **114**, third and fourth upper-layer insulation layers **145**, **115** are laminated respectively. Third and fourth upper-layer insulation layers **145**, **115** are also formed by curing a prepreg made, for example, by impregnating glass cloth with resin. In third and fourth upper-layer insulation layers **145**, **115**, vias (second upper-layer vias) **147**, **121** connected to vias **146**, **119** are formed respectively. Vias **147**, **121** are filled respectively with conductors **149**, **122** made of copper, for example. Conductors **149**, **122** are electrically connected to conductors **148**, **120** respectively. Accordingly, filled build-up vias are formed by vias **146**, **147**, **119**, **121**.

On the top surfaces of third and fourth upper-layer insulation layers **145**, **115**, conductive patterns (circuit patterns) **150**, **123** are formed respectively. Then, by connecting vias **147**, **121** to predetermined spots of conductive patterns **150**, **123** respectively, conductive layer **133** and conductive pattern **123** are electrically connected through wiring pattern **117**, extended pattern **118**, conductor **120** and conductor **122**; and conductive layer **132** and conductive pattern **150** are electrically connected through wiring pattern **142**, extended pattern **143**, conductor **148** and conductor **149**.

On the top surfaces of third and fourth upper-layer insulation layers **145**, **115**, fifth and sixth upper-layer insulation layers **172**, **173** are further laminated respectively as shown in FIG. **3**. Fifth and sixth upper-layer insulation layers **172**, **173** are also formed by curing a prepreg made, for example, by impregnating glass cloth with resin.

In fifth and sixth upper-layer insulation layers **172**, **173**, vias **174**, **175** connected to vias **147**, **121** are formed respectively. On the top and bottom of the substrate including the inner surfaces of vias **174**, **175**, conductive patterns **176**, **177** made of copper, for example, are formed respectively. Conductive patterns **176**, **177** are electrically connected to conductors **149**, **122** respectively. Moreover, on the top and bottom of the substrate, patterned solder resists **298**, **299** are formed respectively. Electrodes **178**, **179** (connection terminals) are formed, for example, by chemical gold plating at each predetermined spot in conductive patterns **176**, **177**.

On a surface of flex-rigid wiring board **10**, for example, as shown in FIG. **5**, using for example, a flip-chip connection, electronic component **501** such as a CPU is mounted on rigid substrate **11** and electronic component **502** such as memory is mounted on rigid substrate **12**. Then, the wiring board is sealed, for example, in rectangular packaging **101**. Packaging **101** may be given any shape; it may be square, for example. Also, any material is selected for packaging **101**; for example, packaging made of metal, ceramic or plastic may be used. Also, the type of packaging **101** may be selected freely; for example, any packaging such as DIP, QFP, PGA, BGA or CSP may be used. In addition, electronic components **501**, **502** are not limited to active components such as an IC circuit, but may be passive components such as a resistor, capacitor or

coil. Furthermore, any method for mounting electronic components **501**, **502** may be employed; for example, they may be mounted by wire bonding.

Then, flex-rigid wiring board **10** is mounted by a surface-mounting method using, for example, soldering, on motherboard **100** which is a rigid substrate. Accordingly, an electronic device is formed. Since such an electronic device is reinforced by flexible substrate **13** on the side where flex-rigid wiring board **10** is mounted, even when an impact is exerted from being dropped or the like, such an impact is reduced on the side where motherboard **100** is. Thus, cracks may seldom occur in motherboard **100**. Motherboard **100** is a printed wiring board of sufficient size to install multiple printed circuit boards; it has connection terminals for connection to printed circuit boards, and includes an expansion board (daughter board) or the like. As for motherboard **100**, a rigid printed wiring board that has larger wiring pitches than rigid substrates **11**, **12** is used here. Also, any method for mounting flex-rigid wiring board **10** may be employed; for example, it may be mounted by an insertion mounting method (pin connection).

Electronic components **501**, **502** are electrically connected to each other through signal lines formed with the conductors in flex-rigid wiring board (wiring patterns **117**, **142**, extended patterns **118**, **143**, conductors **120**, **122**, **148**, **149**, conductive patterns **123**, **124**, **150**, **151**, **176**, **177**, conductive layers **132**, **133** and so forth). Those signal lines allow mutual signal transmission. Those signal lines electrically connect electronic component **501** and electronic component **502** using routes that avoid through-holes **163**. Accordingly, signals between electronic components **501**, **502** are transmitted only along the upper side of the substrate (outside the boundary of the core, on the side of rigid substrates **11**, **12** where the electronic components are mounted); signals are not transmitted from the upper side to the lower side (outside the boundary of the core, on the side where motherboard **100** is positioned). Namely, for example, signals from electronic component **502** (memory) are transmitted to electronic component **501** (CPU) through, for example, as arrows (L**1**) show in FIG. **5**, conductors **122**, **120**, extended pattern **118**, wiring pattern **117**, conductive layer **133**, wiring pattern **117**, extended pattern **118**, conductors **120**, **122** in that order (see FIGS. **3**-**4** for detail). By making such a structure, the route for signal transmission between electronic components is made shorter without detouring to motherboard **100**. By shortening the signal transmission route, the parasitic capacitance or the like is reduced. Accordingly, high-speed signal transmission between electronic components may be achieved. Also, by shortening the signal transmission route, noise contained in the signal is reduced.

By making such a structure, electrical signals between electronic component **501** and electronic component **502** may be transmitted without using connectors. Thus, the cost of electronic devices may be reduced.

On the other hand, a power source for electronic components **501**, **502** is supplied from motherboard **100**. Namely, the conductors in flex-rigid wiring board **10** form power-source lines to supply a power source from motherboard **100** to each of electronic components **501**, **502**. The power-source lines provide a power source for each of electronic components **501**, **502** by the routes through conductors **149**, **148**, through-hole **163** and conductors **120**, **122** (see FIG. **3** for detail), as arrows (L**2**) show in FIG. **5**, for example. In so structuring, while a required power source is provided for each of electronic components **501**, **502**, high-speed signal transmission between electronic components **501**, **502** may be achieved.

When manufacturing flex-rigid wiring board **10**, flexible substrate **13** (FIG. **2**) is manufactured first. Specifically, a copper film is formed on both surfaces of polyimide base material **131** prepared to be a predetermined size. In the following, by patterning the copper films, conductive layers **132**, **133** are formed that have wiring patterns (**13***a*) and connection pads (**13***b*). Then, on each surface of conductive layers **132**, **133**, insulation films **134**, **135** made of polyimide, for example, are formed through a laminating process. Furthermore, after silver paste is applied on insulation films **134**, **135** except for the tips of flexible substrate **13**, the silver paste is cured to form shield layers **136**, **137**. Then, coverlays **138**, **139** are formed to cover each surface of shield layers **136**, **137**. Here, shield layers **136**, **137** and coverlays **138**, **139** are formed to avoid connection pads (**13***b*).

Through such a series of steps, a wafer having a laminated structure shown in FIG. **2** is completed. Such a wafer is used as a material commonly used for multiple products. Namely, as shown in FIG. **6**, by cutting the wafer into a predetermined size using a laser or the like, flexible substrate **13** of a predetermined size is obtained.

Next, flexible substrate **13** as manufactured above is bonded with each rigid substrate of first and second rigid substrates **11**, **12**. Before bonding, as shown in FIG. **7**, for example, first and second insulation layers **111**, **113** of a predetermined size are prepared by cutting a wafer commonly used for multiple products using a laser or the like. Also, as shown in FIG. **8**, for example, separators **291** of a predetermined size are prepared by cutting a wafer commonly used for multiple products by a laser or the like.

Also, rigid base material **112** that makes the core for rigid substrates **11**, **12** is produced from wafer **110** commonly used for multiple products as shown in, for example, FIG. **9**. Namely, after conductive films (**110***a*, **110***b*) made of copper, for example, are formed on the top and bottom of wafer **110** respectively, conductive films (**110***a*, **110***b*) are patterned to form conductive patterns (**112***a*, **112***b*) through, for example, a predetermined lithography process (pretreatment, laminating, exposing to light, developing, etching, removing the film, inspecting inner layers and so forth). Then, using a laser or the like, a predetermined portion of wafer **110** is removed to obtain rigid base materials **112** for rigid substrates **11**, **12**. After that, a black-oxide treatment is conducted on rigid base material **112** as manufactured above.

Rigid base material **112** is formed, for example, with glass-epoxy base material of a thickness in the range of 50-150 μm, preferably an approximate thickness of 100 μm; first and second insulation layers **111**, **113** are formed, for example, with a prepreg of a thickness in the range of 20-50 μm. Separator **291** is formed, for example, with a cured prepreg or polyimide film or the like. The thicknesses of first and second insulation layers **111**, **113** are set at substantially the same thickness so as to make, for example, a symmetrical structure on the top and bottom of rigid substrates **11**, **12**. The thickness of separator **291** is set to be substantially the same thickness as that of second insulation layer **113**. Also, the thickness of rigid base material **112** and the thickness of flexible substrate **13** are preferred to be made substantially the same. By doing so, resin will be filled in spaces formed between rigid base material **112** and coverlays **138**, **139**. Accordingly, flexible substrate **13** and rigid base material **112** may be bonded more securely.

In the following, first and second insulation layers **111**, **113**, rigid base materials **112** and flexible substrate **13** that were cut in the process shown in FIGS. **6**, **7**, **9** are aligned and arranged, for example, as shown in FIG. **10**A. During that

time, each tip of flexible substrate **13** is sandwiched between first and second insulation layers **111**, **113** and then aligned.

Furthermore, as shown in FIG. **10**B, for example, separator **291** that was cut in the step shown in FIG. **8** is arranged side by side with second insulation layer **113** on one surface (for example, the upper surface) of flexible substrate **13** which is exposed between rigid substrate **11** and rigid substrate **12**. Then, conductive films **161**, **162** made of copper, for example, are disposed on the outside (both top and bottom). Separator **291** is secured using, for example, an adhesive agent. By making such a structure, since separator **291** supports conductive film **162**, problems, such as broken copper foil caused by a plating solution that is seeped into the space between flexible substrate **13** and conductive film **162**, may be prevented or suppressed.

Next, the structure, as so aligned (FIG. **10**B), is pressure-pressed as shown, for example, in FIG. **10**C. During that time, resin **125** is squeezed from each prepreg that forms first and second insulation layers **111**, **113**. As shown in FIG. **4**, the space between rigid base material **112** and flexible substrate **13** is filled by resin **125**. As such, by filling the space with resin **125**, flexible substrate **13** and rigid base material **112** are adhered securely. Such pressure-pressing is conducted using, for example, hydraulic pressing equipment, under the approximate conditions of temperature at 200° C., pressure at 40 kgf and pressing time of three hours.

In the following, the entire structure is heated or the like, the prepreg forming first and second insulation layers **111**, **113** and resin **125** are cured and integrated. At that time, coverlays **138**, **139** (FIG. **4**) of flexible substrate **13** and first and second insulation layers **111**, **113** are polymerized. By polymerizing the resin of insulation layers **111**, **113**, the surroundings of vias **141**, **116** (they will be formed in the later process) are secured with resin, thus enhancing connection reliability of each connection section between vias **141** and conductive layer **132** (or between vias **116** and conductive layer **133**).

Next, after a predetermined pretreatment, for example, a CO_2 laser is beamed using CO_2 laser processing equipment to form through-holes **163** as shown in FIG. **10**D. During that time, vias **116**, **141** (for example, IVHs (Interstitial Via Holes)) are also formed to connect conductive layers **132**, **133** of flexible substrate **13** (FIG. **4**) and rigid substrates **11**, **12** respectively.

In the following, after conducting desmear treatment (removing smears) and soft etching, for example, as shown in FIG. **10**E, PN plating (for example, chemical copper plating and electrical copper plating) is performed to plate copper on the entire surfaces of the structure. The copper from such copper plating and already existing conductive films **161**, **162** are integrated to form copper films **171** on the entire surfaces of the substrate including the inner surfaces of vias **116**, **141** and the inner surfaces of through-holes **163**. During that time, since flexible substrate **13** is covered by conductive films **161**, **162**, it is not directly exposed to the plating solution. Therefore, flexible substrate **13** will not be damaged by the plating solution.

In the following, copper films **171** on the surfaces of the substrate are patterned, for example, as shown in FIG. **10**F, through a predetermined lithography process (pretreatment, laminating, exposing to light, developing, etching, removing the film, inspecting inner layers and so forth). By doing so, wiring patterns **142**, **117** and extended patterns **143**, **118** are formed to be connected to conductive layers **132**, **133** of flexible substrate **13** (FIG. **4**) respectively. At that time, copper foil is kept on each tip of first and second insulation layers **111**, **113** on the side of flexible substrate **13**. After that, a black oxide treatment is performed on the resultant structure.

In the following, as shown in FIG. **11**A, for example, on the top and bottom of the resultant structure, first and second upper-layer insulation layers **144**, **114** are disposed respectively. Then, conductive films (**114***a*, **144***a*) made of copper, for example, are further disposed outside those layers. After that, as shown in FIG. **11**B, the structure is pressure-pressed. At that time, vias **116**, **141** are filled with the resin squeezed from the prepreg each forming first and second upper-layer insulation layers **114**, **144**. Then, the prepreg and the resin in the vias are set through thermal treatment or the like to cure first and second upper-layer insulation layers **144**, **114**.

In the following, conductive films (**114***a*, **144***a*) are made thinner to a predetermined thickness by half etching, for example. Then, after a predetermined pretreatment, using a laser, for example, vias **146** are formed in first upper-layer insulation layer **144**, and vias **119** and cutoff line **292** are formed in second upper-layer insulation layer **114**. Then, after conducting desmear treatment (removing smears) and soft etching, for example, as shown in FIG. **11**C, conductors are formed in the interiors of vias **146**, **119** and cutoff line **292** through PN plating (for example, chemical copper plating and electrical copper plating). Such conductors may also be formed by printing conductive paste (for example, thermosetting resin containing conductive particles) by screen printing.

In the following, the conductive films on the surfaces of the substrate are made thinner to a predetermined thickness by half etching, for example. Then, the conductive films on the surfaces of the substrate are patterned through, for example, a predetermined lithography process (pretreatment, laminating, exposing to light, developing, etching, removing the film, inspecting inner layers and so forth) as shown in FIG. **11**D. By doing so, conductors **148**, **120** are formed. Also, the conductor in cutoff line **292** is removed by etching. Then, a black oxide treatment is performed on the resultant structure.

Here, before describing the next process, a step conducted prior to such process is described. Namely, prior to the next process, as shown in FIG. **12**, a wafer used commonly for multiple products is cut using a laser or the like, for example, to form third and fourth upper-layer insulation layers **145**, **115** of a predetermined size.

Then, in the following process, as shown in FIG. **13**A, on the top and bottom of the substrate, third and fourth upper-layer insulation layers **145**, **115**, which were cut in the process shown in FIG. **12**, are disposed. Then, on their outside (on both top and bottom), conductive films (**145***a*, **115***a*) made of copper, for example, are disposed. As shown in FIG. **13**A, fourth upper-layer insulation layer **115** is disposed, but to leave a gap over cutoff line **292**. After that, by heating or the like, third and fourth upper-layer insulation layers **145**, **115** are cured. Third and fourth upper-layer insulation layers **145**, **115** are each formed with a regular prepreg made, for example, by impregnating glass cloth with resin.

In the following, the resultant structure is pressed as shown in FIG. **13**B. After that, conductive films (**145***a*, **115***a*) are each made thinner to a predetermined thickness by half etching, for example. Then, after conducting pretreatment, vias **147**, **121** are formed in third and fourth upper-layer insulation layers **145**, **115** respectively using a laser, for example. After conducting a desmear process (removing smears) and soft etching, vias **147**, **121** are filled with conductor, for example, as shown in FIG. **13**C, through PN plating (for example, chemical copper plating and electrical copper plating). In doing so, by filling the interiors of vias **147**, **121** with the same conductive paste material, connection reliability may be

enhanced when thermal stresses are exerted on vias **147**, **121**. The conductor may also be formed by printing conductive paste (such as thermosetting resin containing conductive particles) by, for example, screen printing.

In the following, as shown in FIG. **13**D, the surfaces of the substrate are made thinner to a predetermined thickness by half etching, for example. After that, the copper films on the substrate surfaces are patterned, for example, through a predetermined lithography process (pretreatment, laminating, exposing to light, developing, etching, removing the film, inspecting inner layers and so forth). In doing so, conductors **149**, **122** and conductive patterns **150**, **123** are formed. Then, a black oxide treatment is performed on the resultant structure.

Next, as shown in FIG. **14**A, fifth and sixth upper-layer insulation layers **172**, **173** are disposed on the top and bottom of the resultant structure, then on its outside (on both top and bottom), conductive films (**172***a*, **173***a*) made of copper, for example, are disposed. Fifth and sixth upper-layer insulation layers **172**, **173** are formed, for example, with a prepreg made by impregnating glass cloth with resin.

In the following, the structure is pressed as shown in FIG. **14**B. After that, conductive films (**172***a*, **173***a*) are made thinner to a predetermined thickness by half etching, for example. Then, after conducting a predetermined pretreatment, vias **174**, **175** are formed respectively in fifth and sixth upper-layer insulation layers **172**, **173** by laser beams or the like. Also, as shown in FIG. **14**C, the insulation layer in each portion indicated by the broken lines in FIG. **14**B, namely, the insulation layer at the edges of separator **291** (the border portions between second insulation layer **113** and separator **291**), is removed, and cutoff lines (notches) (**294***a*-**294***c*) are formed. At that time, cutoff lines (**294***a*-**294***c*) are formed (cut) using, for example, conductive patterns **151**, **124** as a stopper. During that time, the energy or beam time may be adjusted so that a certain amount of conductive patterns **151**, **124**, which are used as a stopper, will be cut.

In the following, by performing PN plating (for example, chemical copper plating and electrical copper plating), conductors are formed on the entire surfaces of the substrate including the interiors of vias **174**, **175**. Then, the copper foils on the substrate surfaces are made thinner to a predetermined thickness by half etching, for example. After that, the copper foils on the substrate surfaces are patterned, for example, through a predetermined lithography process (pretreatment, laminating, exposing to light, developing, etching, removing the film and so forth). In doing so, conductive patterns **176**, **177** are formed as shown in FIG. **14**D. After forming the conductive patterns, those patterns are inspected.

In the following, solder resists are formed on the entire surfaces of the substrate by screen printing, for example. Then, as shown in FIG. **14**E, the solder resists are patterned through a predetermined lithography process. After that, patterned solder resists **298**, **299** are set, for example, by heating or the like.

In the following, after drilling and outline processing are conducted around the edges of separator **291** (see broken lines in FIG. **14**B), structures **301**, **302** are removed by tearing them off from flexible substrate **13** as shown in FIG. **15**A. During that time, separation is easily done because of separator **291**. Also, when structures **301**, **302** are separated (removed) from the rest, since conductive patterns (**151**, **124**) are not adhered, but are only pressed onto coverlays **138**, **139** of flexible substrate **13** (see FIG. **10**C), conductive patterns **124**, **151** are also removed along with structures **301**, **302**.

As described, by exposing the center portion of flexible substrate **13**, spaces (regions (R**1**, R**2**)) which allow flexible substrate **13** to warp (bend) are formed on the top and bottom (in the direction where insulation layers are laminated) of flexible substrate **13**. By doing so, flex-rigid wiring board **10** may be bent or the like at those portions of flexible substrate **13**.

At the tip of each insulation layer facing the removed areas (region (R**1**, R**2**)), conductive patterns **124**, **151** remain as shown, for example, in broken lines in FIG. **15**B. The remaining copper is removed according to requirements by, for example, mask etching (pretreatment, laminating, exposing to light, developing, etching, removing the film and so forth) as shown in FIG. **15**C.

In the following, electrodes **178**, **179** are formed by chemical gold plating, for example. After that, through outline processing, warp correction, conductivity testing, exterior inspection and final inspection, flex-rigid wiring board **10** is completed as shown earlier in FIG. **3**. As described above, flex-rigid wiring board **10** has a structure in which the tips of substrate **13** are sandwiched between the core sections (first and second insulation layers **111**, **113**) of rigid substrates **11**, **12**, and lands of rigid substrates **11**, **12** and connection pads of the flexible substrate are connected respectively through plated metallic layers.

On flex-rigid wiring board **10**, specifically on each surface of rigid substrates **11**, **12**, electronic components **501**, **502** are mounted respectively. After the board is sealed in packaging **101** as shown earlier in FIG. **5**, and mounted on motherboard **100**, an electronic device according to an embodiment of the present invention is completed.

In the above, a flex-rigid wiring board and an electronic device according to an embodiment of the present invention were described. However, the present invention is not limited to such an embodiment.

When mounting flex-rigid wiring board **10** on motherboard **100**, a bare chip may be mounted directly, not by means of packaging **101**. For example, as shown in FIG. **16**, a bare chip may be mounted on motherboard **100** by a flip-chip connection using, for example, conductive adhesive agent (**100***a*). Alternatively, for example, as shown in FIG. **17**, a bare chip may be mounted on motherboard **100** by means of spring (**100***b*). Also alternatively, for example, as shown in FIG. **18**, a bare chip may be mounted on motherboard **100** by wire bonding through wiring (**100***c*). Also alternatively, for example, as shown in FIG. **19**, build-up vias are formed all the way to the upper layer of motherboard **100**, and both substrates may be electrically connected by means of section through-holes (plated through-holes) (**100***d*). Also, both substrates may be electrically connected through connectors. Any method may be employed for mounting both substrates.

Furthermore, the quality or material of the electrodes and wiring for electrical connection of both substrates is not limited to a specific type. For example, both substrates may be electrically connected by ACF (Anisotropic Conductive Film) connection or Au—Au connection. It may be easier by ACF connection to align flex-rigid wiring board **10** and motherboard **100**. Also, using an Au—Au connection, connected sections may be formed to be corrosion-resistant.

Electronic components **503**, **504** may be placed into flex-rigid wiring board **10** as shown in FIG. **20**. By using flex-rigid wiring board **10** with built-in electronic components, electronic devices may be made highly functional. Here, electronic components **503**, **504** may be, for example, active components such as an IC circuit or the like, or passive components such as a resistor, condenser (capacitor) or coil.

In the above embodiment, the option exists to modify the material and size of each layer and the number of layers. For example, instead of a prepreg, an RCF (Resin Coated Copper Foil) may be used.

Also, in the above embodiment, as shown in FIG. **21**A, rigid substrates **11**, **12** and flexible substrate **13** were electrically connected respectively through filled conformal vias in second upper-layer insulation layer **114** (insulation resin) (see FIG. **4** for detail). However, the present invention is not limited to such. For example, as shown in FIG. **21**B, both substrates may be connected by through-holes. However, in such a structure, the impact from being dropped or the like may concentrate in the inner-wall portions of the through-holes, and thus cracks may more easily occur at the shoulder sections of through-holes, compared with conformal vias. Other than such, for example, as shown in FIG. **21**C, both substrates may be connected by filled vias. In such a structure, impacts from being dropped or the like may be exerted on the entire vias, thus suppressing cracks compared with conformal vias. The interiors of such conformal vias and through-holes may be filled with conductive resin.

Also, as shown in FIG. **22**, rigid substrate **11** may have conductor (wiring layers) only on either the top or the bottom of the core (the same in rigid substrate **12**). Also, three or more rigid substrates may be connected by flexible substrates.

The structure of the above embodiment or modified examples may be put together (used together) with the above-described mid-air highway structure.

A flex-rigid wiring board according to an embodiment of the present invention has a flexible printed wiring board with a first conductive pattern and a rigid printed wiring board with a second conductive pattern. An insulation layer covers at least part of the flexible printed wiring board and at least part of the rigid printed wiring board while exposing at least part of the flexible printed wiring board, a first connection terminal for mounting the flex-rigid wiring board onto a motherboard, and a second connection terminal for mounting an electronic component onto the flex-rigid wiring board, where the second conductive pattern is formed on the insulation layer and the first conductive pattern and the second conductive pattern are connected through a plated metallic layer that penetrates the insulation layer.

The flexible wiring board may be structured in such a way that it is partially a flex-rigid wiring board.

The rigid printed wiring board may be structured in such a way that it is arranged horizontally to the flexible printed wiring board.

An electronic device according to another embodiment of the present invention has a motherboard and a flex-rigid wiring board. The flex-rigid wiring board is made up of a flexible printed wiring board having a first conductive pattern, a rigid printed wiring board having a second conductive pattern, and an insulation layer covering at least part of the flexible printed wiring board and at least part of the rigid printed wiring board while exposing at least part of the flexible printed wiring board. The second conductive pattern is formed on the insulation layer. The first conductive pattern and the second conductive pattern are connected through a plated metallic layer that penetrates the insulation layer; on a surface of the motherboard, at least one of the flex-rigid wiring boards is mounted. On a surface of the rigid printed wiring board, at least one electronic component is mounted.

The structure may be formed in such a way that multiple electronic components are mounted on a surface of the rigid printed wiring board; the multiple electronic components are electrically connected to each other through a signal line that is formed with the first conductive pattern and the second conductive pattern; the flex-rigid wiring board has a through-hole that electrically interconnects the conductive patterns on both surfaces of the substrate; and, in the first and second conductive patterns, at least the signal line electrically connects the multiple electronic components with each other using a route that avoids the through-hole.

The structure may be formed in such a way that the second conductive pattern forms a power-source line which provides a power source for the multiple electronic components from the mother board; and, in the second conductive pattern, at least the power-source line passes through the through-hole and provides a power source for the multiple electronic components.

An electronic device according to yet another embodiment of the present invention has a flex-rigid wiring board. The flex-rigid wiring board is made up of a flexible printed wiring board having a first conductive pattern, a rigid printed wiring board having a second conductive pattern, and an insulation layer covering at least part of the flexible printed wiring board and at least part of the rigid printed wiring board while exposing at least part of the flexible printed wiring board. The second conductive pattern is formed on the insulation layer. The first conductive pattern and the second conductive pattern are connected through a plated metallic layer that penetrates the insulation layer. On a surface of the rigid printed wiring board, at least one electronic component is mounted. A connection terminal is formed on the flex-rigid wiring board to mount the flex-rigid wiring board onto a mother board.

An electronic device according to still another embodiment of the present invention has a flex-rigid wiring board. The flex-rigid wiring board is made up of a flexible printed wiring board having a first conductive pattern, a rigid printed wiring board having a second conductive pattern, and an insulation layer covering at least part of the flexible printed wiring board and at least part of the rigid printed wiring board while exposing at least part of the flexible printed wiring board. The second conductive pattern is formed on the insulation layer. The first conductive pattern and the second conductive pattern are connected through a plated metallic layer that penetrates the insulation layer. The rigid printed wiring board has at least one built-in electronic component. On a surface of the rigid printed wiring board, at least one electronic component is mounted. A connection terminal is formed on the flex-rigid wiring board to mount the flex-rigid wiring board onto a mother board.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed is:

1. A flex-rigid wiring board comprising:

a flexible printed wiring board having first and second ends, and comprising a first conductive layer;

a rigid printed wiring board having a rigid base material, an insulation layer over the rigid base material and a second conductive layer formed over the insulation layer,

wherein the insulation layer covering at least a portion of said first end of the flexible printed wiring board and at least a portion of the rigid base material while exposing at least a portion of the flexible printed wiring board, and the first conductive layer and the second conductive layer are connected through a plated metallic layer penetrating through the insulation layer and through a portion of the flexible printed wiring board;

a connection terminal formed on a surface of the rigid printed wiring board and configured to mount an integrated circuit processing chip;

another rigid printed wiring board connected to said second end of the flexible printed wiring board and having another surface which faces a same direction as said surface of the rigid printed wiring board; and

another connection terminal formed on said another surface of the another rigid printed wiring board and configured to mount an integrated circuit memory chip, the another connection terminal being electrically connected to the first conductive layer of the flexible printed wiring board such that the connection terminal of the rigid wiring board is electrically connected to the another connection terminal of the another rigid wiring board.

2. The flex-rigid wiring board according to claim **1**, wherein the plated metallic layer forms a via structure through the insulation layer.

3. The flex-rigid wiring board according to claim **2**, wherein the via structure is filled with a resin.

4. The flex-rigid wiring board according to claim **1**, wherein the rigid printed wiring board is arranged horizontally to the flexible printed wiring board.

5. The flex-rigid wiring board of claim **1**, wherein said plated metallic layer penetrates a resin area and an insulation layer of the flexible printed wiring board to connect to the first conductive layer.

6. An electronic device comprising:

a motherboard; and

a flex-rigid wiring board mounted on a surface of the motherboard and comprising a flexible printed wiring board having first and second ends, and a rigid printed wiring board and another rigid printed wiring board connected to said first and second ends respectively, wherein:

the flexible printed wiring board has a first conductive layer,

the rigid printed wiring board has a rigid base material,

an insulation layer over the rigid base material and a second conductive layer formed over the insulation layer, the insulation layer covers at least a portion of the first end of the flexible printed wiring board and at least a portion of the rigid base material while exposing at least a portion of the flexible printed wiring board, and the first conductive layer and the second conductive layer are connected through a plated metallic layer penetrating through the insulation layer and through a portion of the flexible printed wiring board,

a connection terminal formed on a surface of the rigid printed wiring board and configured to mount an integrated circuit processing chip;

said another rigid printed wiring board having another surface which faces a same direction as said surface of the rigid printed wiring board; and

another connection terminal formed on said another surface of the another rigid printed wiring board and configured to mount an integrated circuit memory chip, the another connection terminal being electrically connected to the first conductive layer of the flexible printed wiring board such that the connection terminal of the rigid wiring board is electrically connected to the another connection terminal of the another rigid wiring board.

7. The electronic device according to claim **6**, further comprising a first connection terminal formed over the rigid printed wiring board and mounting the flex-rigid wiring board onto the motherboard.

8. The electronic device according to claim **6**, further comprising:

an electronic component; and

a second connection terminal formed over the rigid printed wiring board and mounting the electronic component onto the flex-rigid wiring board.

9. The electronic device according to claim **6**, further comprising an electronic component mounted on a surface of the rigid printed wiring board.

10. The electronic device according to claim **6**, wherein the plated metallic layer forms a via structure through the insulation layer.

11. The electronic device according to claim **10**, wherein the via structure is filled with a resin.

12. The electronic device according to claim **6**, wherein the rigid printed wiring board is arranged horizontally to the flexible printed wiring board.

13. The electronic device according to claim **6**, wherein the first conductive layer and the second conductive layer include a signal line for electrically connecting a plurality of electronic components formed over the flex-rigid wiring board.

14. The flex-rigid wiring board of claim **6**, wherein said plated metallic layer penetrates a resin area and an insulation layer of the flexible printed wiring board to connect to the first conductive layer.

15. An electronic device comprising:

a flex-rigid wiring board comprising a flexible printed wiring board and a rigid printed wiring board, the flexible printed wiring board having first and second ends, and a rigid printed wiring board and another rigid printed wiring board connected to said first and second ends respectively;

an electronic component mounted over a surface of the rigid printed wiring board; wherein:

the flexible printed wiring board has a first conductive layer, the rigid printed wiring board has a rigid base material, an insulation layer over the rigid base material and a second conductive layer formed over the insulation layer, the insulation layer covers at least a portion of the flexible printed wiring board and at least a portion of the rigid base material while exposing at least a portion of the flexible printed wiring board, and the first conductive layer and the second conductive layer are connected through a plated metallic layer penetrating through the insulation layer and through a portion of the flexible printed wiring board,

a connection terminal formed on a surface of the rigid printed wiring board and configured to mount an integrated circuit processing chip;

said another rigid printed wiring board having another surface which faces a same direction as said surface of the rigid printed wiring board; and

another connection terminal formed on said another surface of the another rigid printed wiring board and configured to mount an integrated circuit memory chip, the another connection terminal being electrically connected to the first conductive layer of the flexible printed wiring board such that the connection terminal of the rigid wiring board is electrically connected to the another connection terminal of the another rigid wiring board.

16. The electronic device according to claim **15**, further comprising a second electronic component provided in the rigid printed wiring board.

17. The electronic device according to claim **15**, further comprising a second connection terminal formed on the rigid

printed wiring board and mounting the electronic component on the surface of the flex-rigid wiring board.

18. The electronic device according to claim **15**, wherein the plated metallic layer forms a via structure through the insulation layer.

19. The electronic device according to claim **18**, wherein the via structure is filled with a resin.

20. The electronic device according to claim **18**, wherein the rigid printed wiring board is arranged horizontally to the flexible printed wiring board.

21. The electronic device according to claim **15**, wherein the first conductive layer and the second conductive layer include a signal line for electrically connecting a plurality of electronic components formed over the flex-rigid wiring board.

22. The electronic device according to claim **15**, wherein the flex-rigid wiring board includes a through-hole structure for electrically connecting the second conductive layer and the electronic component, and the second conductive layer includes a power-source line which provides a power source for the electronic component from the motherboard via the through-hole.

23. The flex-rigid wiring board of claim **15**, wherein said plated metallic layer penetrates a resin area and an insulation layer of the flexible printed wiring board to connect to the first conductive layer.

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